Advanced First Aid

A Reference and Training Manual

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Introduction

Part 1 Introduction

Introduction to occupational first aid

The purpose of occupational first aid attendants in the workplace

First aid attendants perform a unique service in the workplace. They alleviate suffering and, on occasion, save lives through their skills at an incident scene. In addition, their effective injury management can often shorten the healing time of the injury, allowing the worker to resume normal activities sooner.

First aid attendants in the workplace must be well trained in all aspects of emergency care, from minor injury management to the most serious trauma care involving airway, breathing, and circulatory emergencies.

Consequently, attendants are required to take on more responsibility than many public first aid courses prepare students for. Frequently, the attendant must decide when to refer the injured worker to medical attention. Many minor injuries can be properly assessed and treated by the well-trained attendant without referral to a physician. In isolated work locations, because of weather conditions or transportation restrictions, the attendant may be required to provide care to the injured for many hours or even overnight. This puts an added burden on the attendant and emphasizes the need for a well-rounded workplace first aid course.

The first aid attendant should never be regarded as a substitute for a physician, and both the employer and workers should be made aware of their limitations. If the attendant has to assume additional responsibilities because of a lack of access to medical facilities, this should be recognized as an undesirable situation.

Where an active workplace joint health and safety committee is in place, work processes are assessed, and safe practices are set up and complied with, the number of accidents will be reduced. Where this is not the case, the number and type of injuries will depend on the inherent hazards of the work.

The first aid attendant should be a part of the workplace health and safety team. It is through this teamwork that injured workers, the employer, and all members of the health and safety team are best served. The health and safety team should hold regularly scheduled meetings to deal with issues around communications, treatments rendered, and reviewing new procedures in emergency care, and changes to local legislation affecting workplace first aid and emergency response requirements.

First aid legislation and the roles and responsibilities of the first aid attendant

Occupational health and safety legislation in most jurisdictions makes reference to treatment of workers injured in workplace accidents and makes it mandatory for the employer to provide trained first aid attendants and first aid supplies appropriate for the circumstances of the workplace. In B.C. the requirements for the provision of first aid are outlined in sections 3.14 to 3.21 of the Occupational Health and Safety Regulation, including Schedule 3-A.

The first aid attendant is in complete charge of all first aid management of injured workers. The attendant's decisions about first aid and the need for medical attention must not be overruled by supervisory personnel.

When the attendant believes that a worker should be transported to a hospital, unless the worker objects, they must be transported to the nearest hospital or diagnostic and treatment centre. If the attendant thinks it necessary to accompany the injured worker during transportation (e.g., the patient requires a stretcher for transport, requires ongoing care, or the attendant is concerned about the stability of the worker's condition), then the attendant should do so. The patient is the responsibility of the attendant until becoming the responsibility of qualified pre-hospital emergency medical personnel or hospital staff. The Regulation gives the attendant responsibility and authority, which should not be abused.

The first aid attendant must not be assigned or accept workplace duties that will not allow immediate response in the event of an emergency. The attendant should also be able to respond in a clean and sanitary condition or have immediate access to a facility for cleanup.

In B.C., the *Workers Compensation Act* provides mutual protection arising from a historic compromise in which workers relinquished their right to sue their employer and the employers agreed to fund a no-fault insurance system. As a result, a worker who is accidentally injured by another worker is barred from suing that other worker or employer for those injuries where both were engaged in the course and scope of employment at the time of the injury. In return for not being able to sue, the historic compromise ensures the injured worker will receive compensation. This means that an attendant who provides first aid services to a worker as part of their employment duties will be protected from liability for inadvertent injury caused by some negligent act or omission. However, this does not preclude the attendant from an investigation and the cancelling or suspension of their first aid certificate if found to have breached a term or condition of the certificate or otherwise contravened the Act or Regulation.

Consent

While a designated first aid attendant has the responsibility and the authority to provide first aid in the workplace, all workers have the right to refuse treatment. As a result, it is important to receive consent from every conscious, mentally competent adult before you provide treatment. There are two types of consent: actual consent and implied consent. Actual consent refers to a patient making an informed decision. This may be provided as verbal consent, or when the patient sits down in the first aid room and presents an injury to the attendant. Implied consent refers to a situation where a patient is unable to respond and the law assumes that the patient would give consent in an emergency situation if able.

First aid equipment in the workplace

All workplaces must be equipped with materials required for first aid treatment in the event of an injury. This requirement is regulated for all workplaces and may also apply to vehicles used to transport workers. Workplace first aid equipment requirements can be found in Schedule 3-A of the Regulation.

First aid kits must be readily available for the attendant to take to the scene of the incident in the event that an injured worker cannot be moved. The kits must be the type that will keep the items clean and dry. The contents of these kits and other first aid equipment should match the attendant's training.

Some workplaces may require a first aid room or dressing station. The first aid room or dressing station should be as near as practicable to the workforce and allow easy access for moving a worker on a stretcher. The first aid room should be well lit, ventilated, and heated. It should contain a sink with plumbed hot and cold water. For ease of cleaning, it should have a non-porous floor.

The door to the first aid room must be clearly marked.

Qualities of the first aid attendant

It is important that OFA attendants perform their duties to the best of their ability. It is equally important that they recognize their own limitations and scope of training.

A pleasant personality and a calm, cool attitude under stress are important for good patient care. A gentle but authoritative approach is desirable. This can help allay the patient's anxiety, which will expedite assessment and treatment.

The OFA attendant must be interested both in first aid and in people and their problems. Certain individuals are quite capable of dealing with an emergency or with a serious injury. Others are not temperamentally able to cope with an emergency or the sight of an injury and are therefore unsuited to work as an OFA attendant.

Part 2

Anatomy

Part 2, Chapter 2

Basic anatomy

2

The human body is a complex structure uniquely suited to survival in our environment. To provide first aid, the attendant must have a basic understanding of human anatomy and function.

Anatomical language

Anatomy is the study of the structure and composition of the human body. The surface of the body has many specific visible features or landmarks that serve as guides to the underlying tissues and organs. Surface anatomy is the identification and recognition of those landmarks.

Visual inspection of the human body is of utmost importance for the provision of first aid because much information about the extent of injury or illness is obtained visually. The first aid attendant must have adequate knowledge of surface anatomy to identify and communicate the patient's physical condition.

Physical findings are usually described in terms of their location relative to specific points or landmarks. To communicate properly with emergency dispatchers, ambulance paramedics, nurses, and physicians, attendants must learn the language of surface anatomy. For example, a laceration may be located 5 cm (2 in.) above the elbow on the inner aspect of the arm. As the attendant will learn, this is best described as being "proximal" to the elbow and located on its "medial" aspect. The key anatomical terms are listed in Table 2-1.

The anatomical position is the reference position for The anatomical position is the reference position for the human body (see Figure 2-1). The terms used to describe surface anatomy are all based on the anatomical position. As shown, the anatomical position is the erect human body facing the attendant. Left and right refer to the patient's left and right, not the attendant's left and right.

An imaginary vertical line drawn from the top of the head through the nose and the navel is called the midline. It divides the body into two halves, right and left. All points further from the midline are referred to as lateral structures; those closer to the midline are called medial structures. For example, the shoulder lies on the lateral aspect of the trunk. The inner and outer corners of the eye are referred to as the medial and lateral corners of the eye.

The terms superior and inferior are used to describe points on the body in relation to specific landmarks. Superior means above or toward the top of the head. Inferior means below or toward the bottom of the feet.

Anatomical terms

Trunk	The torso of the body, including the chest, abdomen, and pelvis. The head and neck, arms, and legs are all attached to the trunk.	**Midline**	The imaginary line from the top of the head through the nose and the navel, dividing the body into left and right halves.
Supine	The patient is lying down on their back.	**Medial**	Closer to the midline.
Prone	The patient is lying down on their stomach.	**Lateral**	The side of the body, away from the midline.
Erect	The patient is standing upright.	**Superior**	Above, or closer to the top of the head.
Anterior	In front. The front of the body is the anterior surface.	**Inferior**	Below, or closer to the bottom of the feet.
Posterior	In back, or behind. The back of the body is the posterior surface.	**Proximal**	Toward the trunk. Used only with respect to a limb.
		Distal	Away from the trunk. Used only with respect to a limb.

Table 2-1

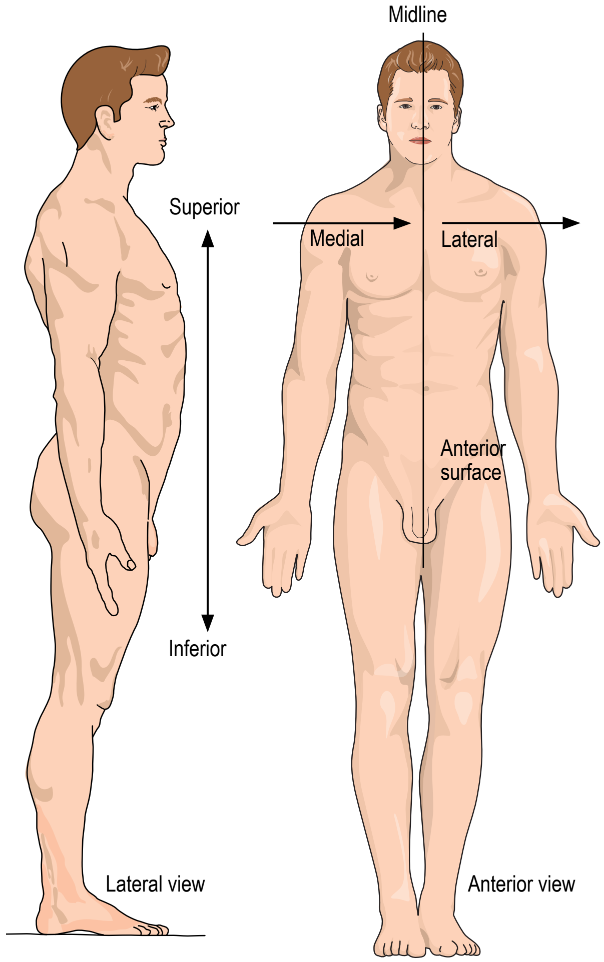


Figure 2-1 Anatomical position

For example, the head is superior to the chest but the abdomen is inferior to the chest. Figure 2-2 shows a wound located on the face. It is described as lateral to the nose but medial to the earlobe. It is inferior to the eye but superior to the mouth. When describing landmarks on the limbs, proximal means toward the trunk and distal means away from the trunk. For example, the radial pulse at the wrist is distal to the elbow but proximal to the thumb. Similarly, the ankle is distal to the knee but proximal to the foot.

The anterior surface refers to the front part of the body. For example, the face is on the anterior surface. The posterior surface refers to the back part of the body. The shoulder blade is located on the posterior surface.

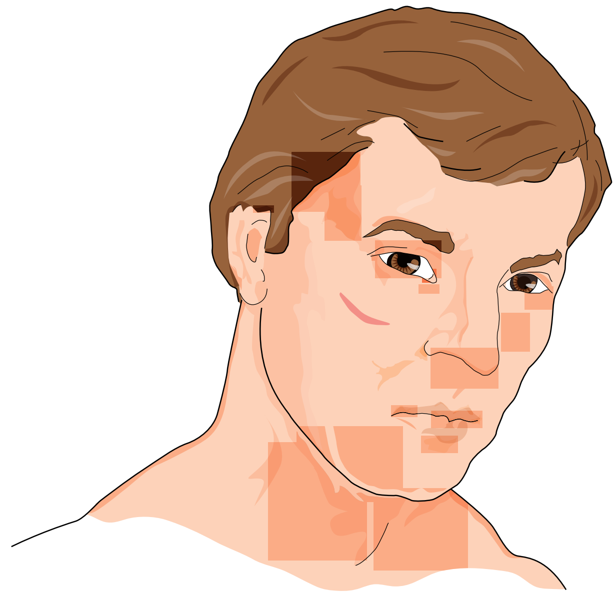


Figure 2-2 Wound location

Because of the structure of the limbs, specific anatomical terms have been devised to describe their surface anatomy. Referring to Figure 2-1 Anatomical position, the attendant should note that in the anatomical position the arms are held with the palms facing forward. Therefore, the palm of the hand is anterior. The back of the hand is posterior. Similarly, the legs are positioned with the toes pointing forward. Therefore, the kneecap (patella) is on the anterior surface. The Achilles tendon, connected to the heel, is posterior.

Cells, tissues, and organs

The basic unit of life is the cell. A bacterium is an organism composed of only one cell. The human body is made up of billions of cells.

In the course of growth and development, cells in the human body become specialized and are organized into tissues. Tissues are groups of cells with similar functions. For example, muscle cells are grouped together to form the various muscles of the body, and a variety of cells are grouped as the connective tissue that gives structural support to the different parts of the body.

Organs are composed of different tissues that are structurally organized to perform a single function. The heart, for example, is composed primarily of specialized muscle tissue and connective tissue.

Systems

The organs and tissues of the body are also organized into specific systems that perform all the major functions of the body. The body has seven major systems:

- The respiratory system includes the lungs and air passages and is responsible for the intake of oxygen, an essential element, and the elimination of carbon dioxide, a waste product.
- The circulatory system (also called the cardiovascular system) includes the heart, blood vessels, and blood; it is the transportation system of the body. It delivers oxygen, glucose, and other essential elements and nutrients to the tissues and carries away waste products.
- The nervous system includes the brain and nerves. It is the control centre and network that coordinates all the systems of the body. It allows us to interpret and respond to our environment.
- The digestive system is made up of the stomach, intestines, and other internal organs required to process the food that we ingest.
- The urinary system is made up of the kidneys, ureters, and bladder. It is responsible for filtering the blood and excreting most of the body's waste products.
- The genital system is made up of the reproductive organs.
- The musculoskeletal system is composed of the bones that provide the body's framework and all the body's muscles, tendons, and ligaments.

Head and neck

The bones of the skull resemble a series of bony plates. They are fused together to form the cranial cavity, which encases the brain.

The primary facial bones are the mandible (lower jaw), the maxilla (upper jaw), the zygoma (cheekbone), the bones of the orbit (around each eye), and the nasal bones (see Figure 2-3 Bones of the face and skull).

The mandible is connected to the skull at a point just anterior to the ear. The action of opening and closing the mouth can be felt at this joint. The lower teeth are set into the mandible. The maxilla is relatively fixed. The upper teeth are set into the maxilla. The hard palate, located in the roof of the mouth, is part of the maxilla.

The nose is only partially formed of bone (at the bridge of the nose); the remainder is made up of cartilage.

The eyes are set into the bony orbits, which protect them. The zygoma forms part of the network of orbital bones.

The neck contains many vital structures, including the airway, trachea, esophagus, and carotid arteries. Figure 2-4 shows a lateral and anterior view of the neck. Anteriorly, the thyroid cartilage, commonly known as the Adam's apple, forms part of the structural framework for the larynx or voice box. Inferior to the thyroid cartilage, the rings of the trachea are palpable. On each side, lateral to the trachea but medial to the sternomastoid muscles, is the carotid artery.

Posteriorly, the bones of the cervical vertebrae are palpable. The most prominent vertebra is the seventh cervical vertebra.

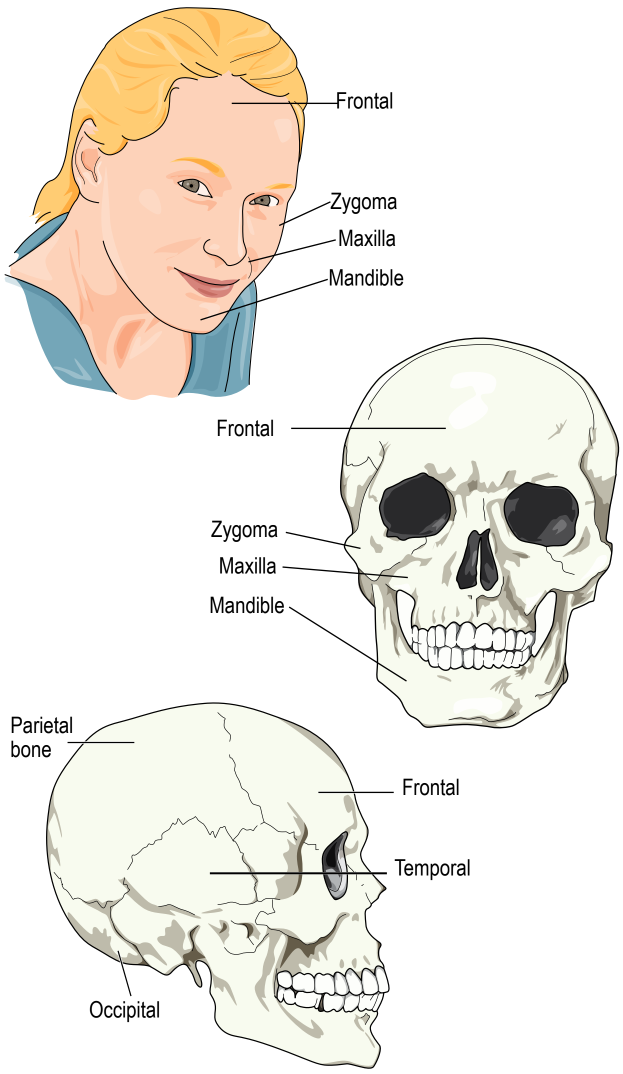
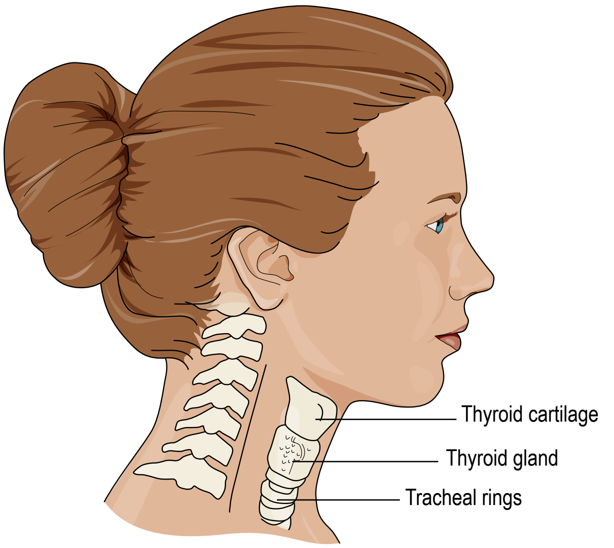


Figure 2-3 Bones of the face and skull



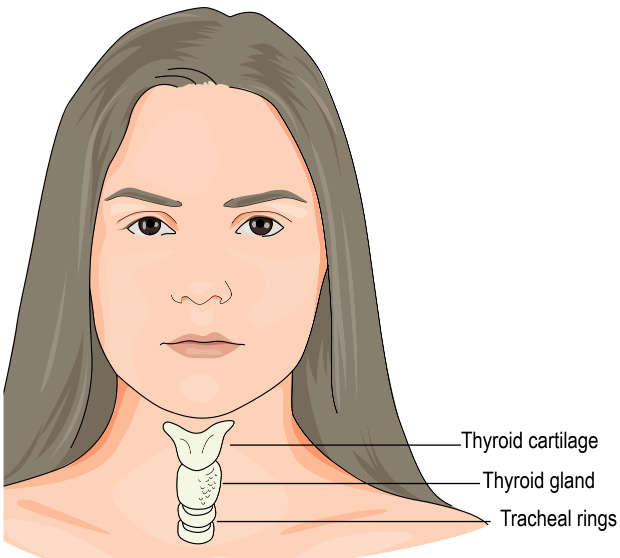


Figure 2-4 Structures of the neck

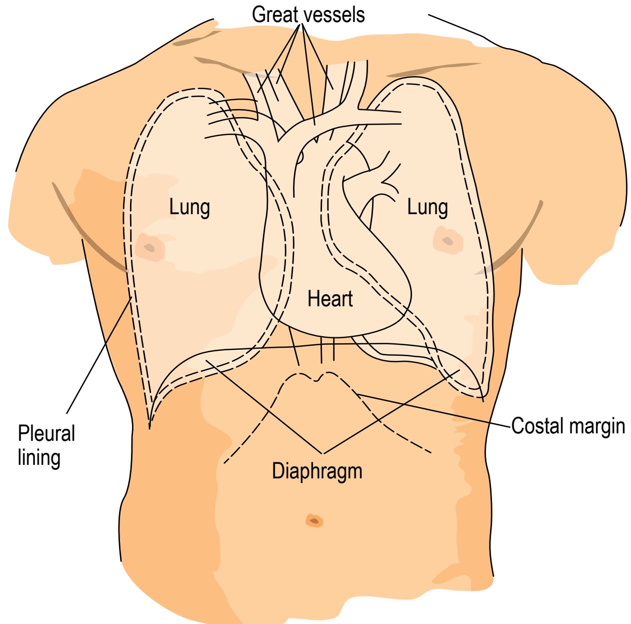


Figure 2-5 Anatomy of the thorax

Thorax

The thorax (chest) contains the heart, lungs, esophagus, and great vessels, all within the thoracic cavity (see Figure 2-5 Anatomy of the thorax). The thoracic cavity is formed posteriorly by the 12 thoracic vertebrae. From the thoracic vertebrae, 12 pairs of ribs curve outward and around to the front; 10 pairs connect anteriorly to the sternum (breastbone). Superiorly lie the clavicles (collarbones), which connect the shoulders to the sternum.

Posteriorly are the scapulae (shoulder blades). Inferiorly, the thoracic cavity is separated from the abdominal cavity by the diaphragm.

The superior end of the sternum forms the suprasternal notch (see Figure 2-6 Surface anatomy of the anterior thorax), which may be palpated. Inferiorly, the sternum ends with a narrow projection called the xiphoid process. The inferior border of the ribs may be palpated anteriorly at the costal margin. The free ends of the 11th and 12th ribs may be palpated in the soft tissue on the lateral aspects of the trunk.

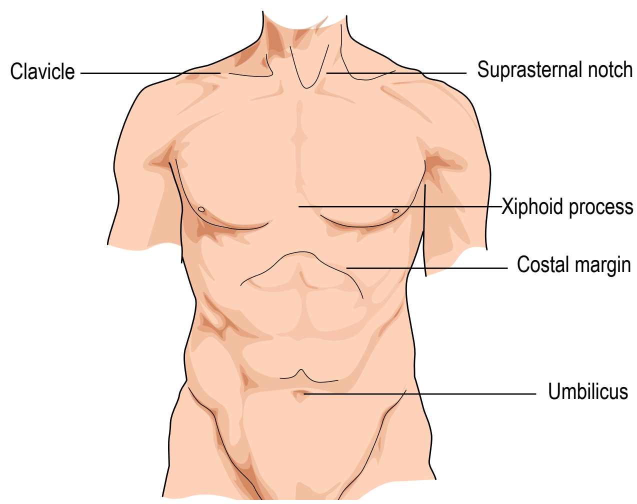


Figure 2-6 Surface anatomy of the anterior thorax

The abdomen

The abdomen contains the organs of the digestive, urinary, and genital systems, as well as the spleen and major blood vessels. The abdomen is bounded superiorly by the diaphragm and inferiorly by the pelvis. Posteriorly, the lumbar vertebrae give structural support. The back, flanks, and anterior abdominal wall are all composed of muscle and connective tissue. The pancreas, kidneys, bladder, parts of the large intestine, and the major blood vessels are all located posteriorly to the abdominal cavity, embedded in the soft tissue of the back, flanks, and pelvis, respectively.

The anterior surface of the abdominal cavity is divided into four quarters or quadrants by the midline and a horizontal line through the umbilicus (navel), as shown in Figure 2-7 Surface anatomy of the abdomen. Location of injuries or complaints of abdominal pain are identified by their relationship to these quadrants. The superior borders of the left upper and right upper quadrants are the costal margins on both sides. The inferior borders of the left lower and right lower quadrants are the inguinal ligaments, which connect the anterior superior iliac spines and the symphysis pubis. The femoral arteries are palpable on both sides lateral o the symphysis pubis and inferior to the inguinal ligament.

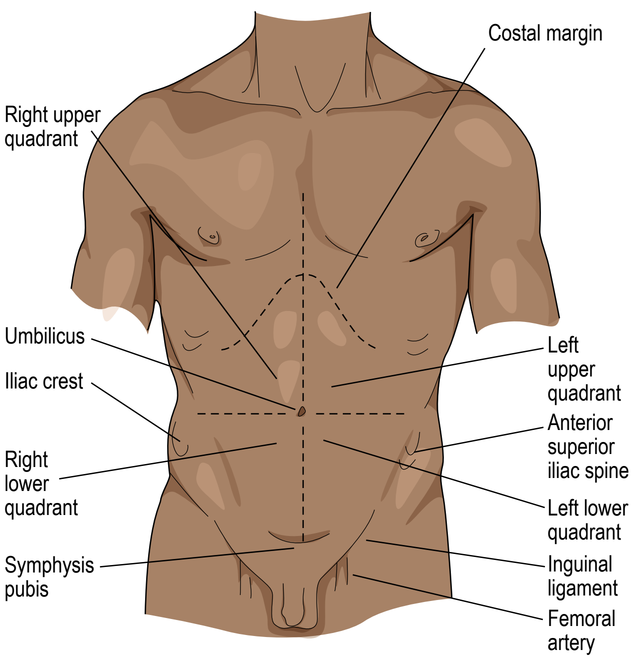


Figure 2-7 Surface anatomy of the abdomen

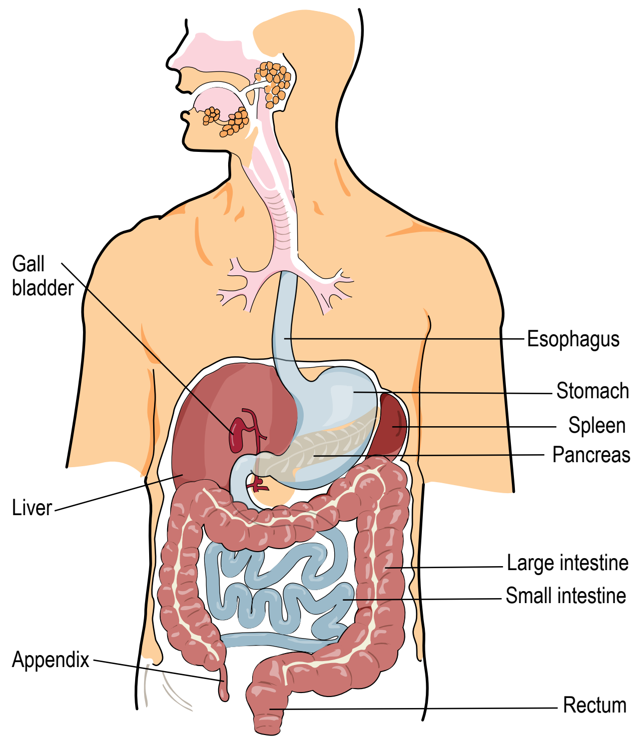


Figure 2-8 Abdominal organs

Figure 2-8 illustrates the anatomical relationship of the abdominal organs to the anterior abdominal wall. Pain or injury to a specific quadrant of the abdomen usually arises from or involves the organs located in that particular quadrant. Therefore, liver injury must be suspected with right upper quadrant trauma. Similarly, rupture of the spleen may be associated with fractures of the left lower ribs. The appendix is a small tubular structure attached to the cecum which is the first part of the large intestine or colon. Inflammation of the appendix is called appendicitis and because of its location, usually presents with pain in the right lower quadrant.

Posteriorly, the surface of the back is not divided into quadrants. Inferiorly, the sacrum and iliac crests are palpable. The kidneys are located in the angles between the 12th rib and the vertebral column (see Figure 2-9 Kidney location).

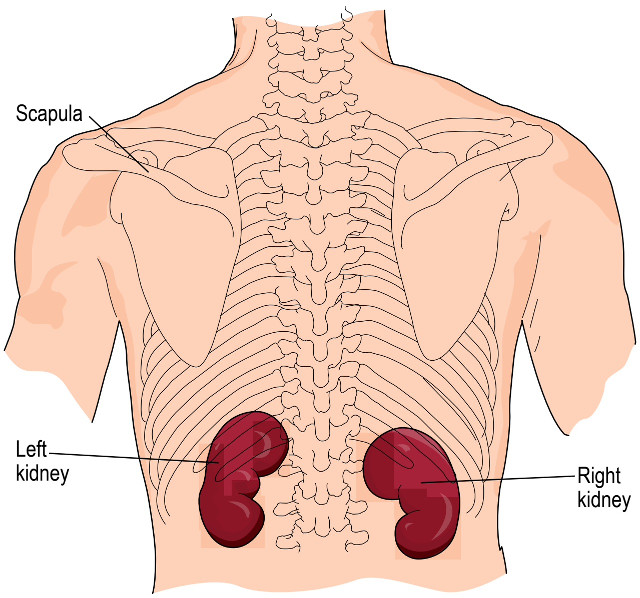


Figure 2-9 Kidney location

Upper extremity

The upper extremity includes the shoulder, upper arm, elbow, forearm, wrist, and hand. The shoulder is a complex structure. The shoulder girdle is composed of the bony structures that make up the shoulder. It consists of the clavicle (collarbone) located anteriorly, the scapula (shoulder blade) located posteriorly, and the proximal end of the humerus (the bone of the upper arm). The clavicle is connected to a bony process of the scapula called the acromion at the acromioclavicular joint (AC joint). This is palpable as a bony prominence on the superior aspect of the shoulder.

The bone of the upper arm, as previously mentioned, is the humerus. Along with the scapula, the proximal end of the humerus forms the shoulder joint. The distal end joins with the radius and ulna (the bones of the forearm) to form the elbow (see Figure 2-10 Anatomy of the upper extremity). The bony processes of the distal humerus are palpable on the medial and lateral aspects of the elbow; they are the medial and lateral epicondyles. The posterior aspect of the elbow is the olecranon process, which forms the proximal end of the ulna. The ulna may be palpated along its entire course, just beneath the skin on the posterior aspect of the forearm. A brachial pulse may be palpated on the anteromedial aspect of the elbow.

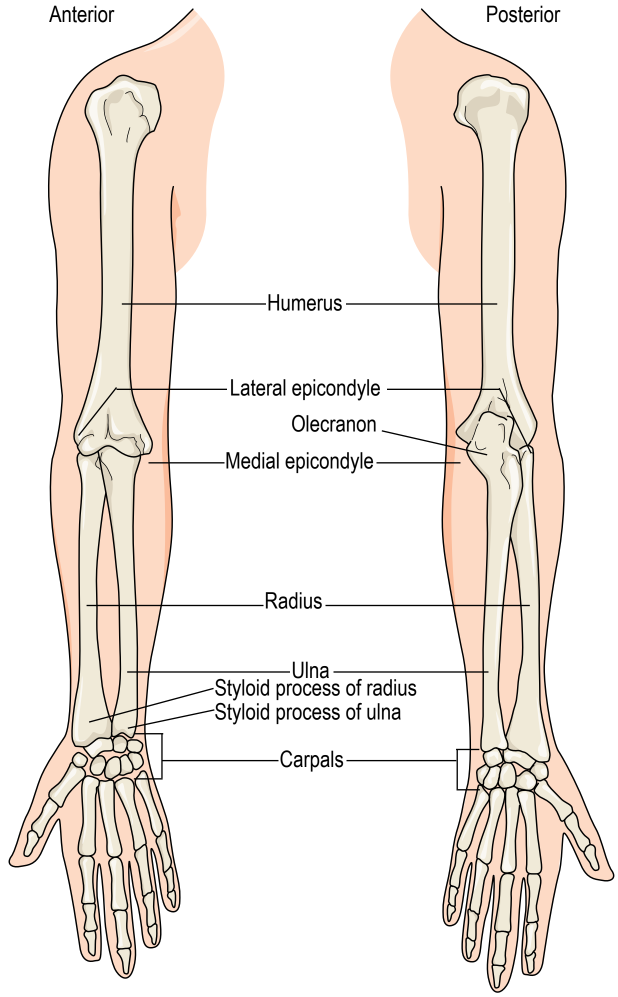


Figure 2-10 Anatomy of the upper extremity

The two bones of the forearm, the radius and ulna, end at the wrist. These two bones permit the hand to rotate. The wrist is a complicated joint by virtue of the complex movements that it performs. It has eight small carpal bones arranged in two rows of four that connect the radius and ulna to the thumb and to the metacarpal bones of the hand. The radial pulse is palpable on the anterior surface of the wrist on its lateral aspect.

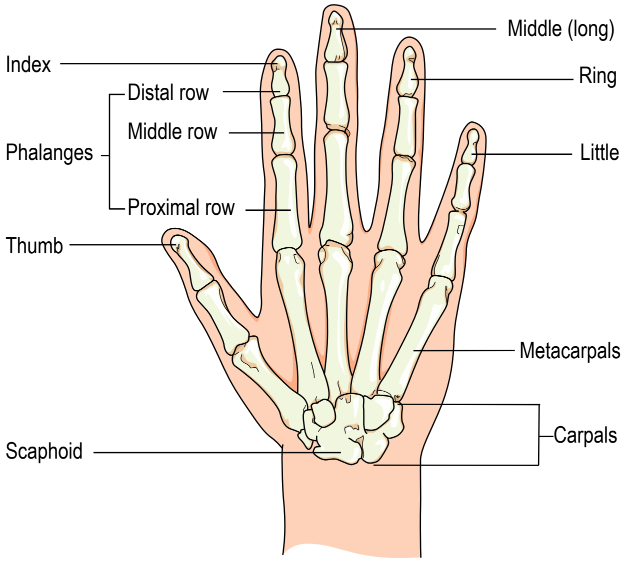


Figure 2-11 Posterior hand

The hand is made up of the palm, the thumb, and four fingers. Five bones called metacarpals form the structural framework of the palm (see Figure 2-11 Posterior hand). The distal ends of the metacarpals are the knuckles. Each finger consists of three small bones called phalanges, whose joints are readily identifiable on the fingers. The thumb has only two phalanges and joins the wrist via one of the metacarpal bones.

Lower extremity

The lower extremity consists of the hip, thigh, knee, calf, ankle, and foot (see Figure 2-12 Anatomy of the lower extremity). The hip joint is formed by the articulation of the femur with the pelvis. A bony projection of the femur (the greater trochanter) is palpable on the lateral aspect of the hip.

The main supporting structure of the thigh is the femur, the longest bone in the body. The femur articulates with the tibia (shin bone), the thicker of the two lower leg bones, to form the knee joint. The proximal end of the fibula, the thinner lower leg bone located lateral and parallel to the tibia, extends to the knee but does not form part of the joint. The patella (kneecap) is located on the anterior aspect of the knee. When the knee is extended and the thigh muscles are relaxed, the patella is very mobile. The distal end of the fibula is palpable at the ankle on its lateral aspect, and the distal end of the tibia is palpable on the ankle's medial aspect. The distal ends of the tibia and fibula articulate with the talus to form the ankle joint.

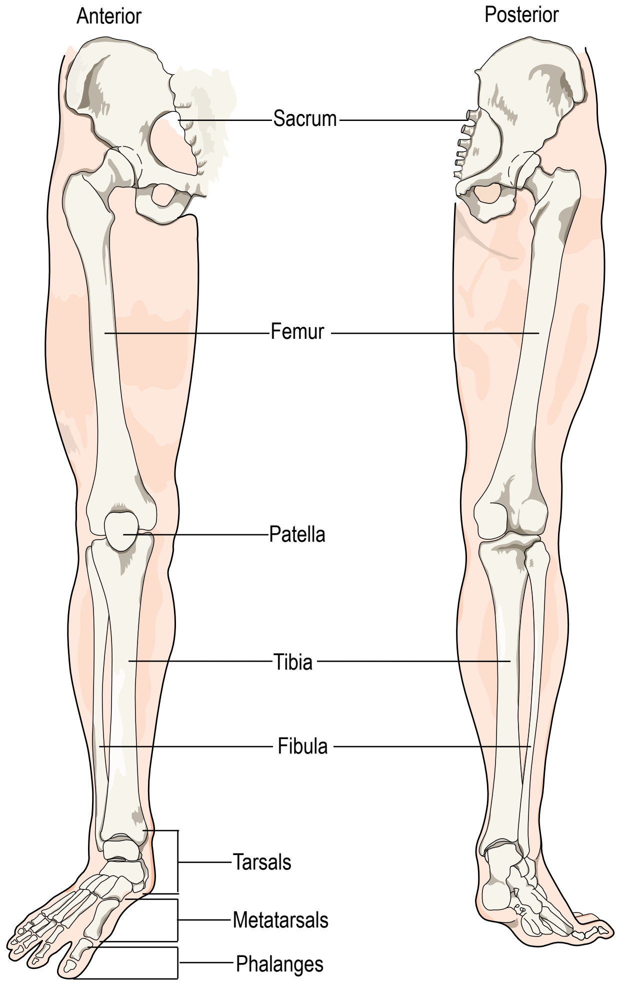


Figure 2-12 Anatomy of the lower extremity

Posterior to the medial prominence of the ankle, the pulse of the posterior tibial artery can be felt.

The foot is a complex structure made up of several tarsal bones, metatarsal bones, and phalanges (see Figure 2-13 Anatomy of the foot). One of the tarsal bones is the heel bone or calcaneus. The big toe, like the thumb, is made up of only two phalanges; all the other toes have three phalanges. Because of the direction of the foot in the anatomical position, there is no true anterior or posterior aspect. Instead, the top of the foot is referred to as its dorsal aspect and the sole as its plantar aspect. On the dorsal surface of the foot, anterior to the ankle, the dorsalis pedis pulse may be palpable.

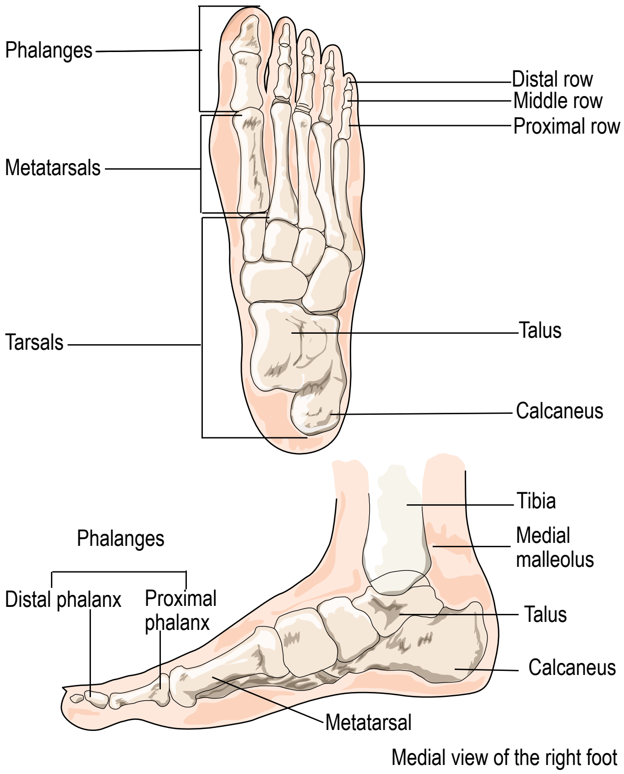


Figure 2-13 Anatomy of the foot

Summary

The attendant must learn the language of surface anatomy. This section has highlighted the most important landmarks of the body and the location of the major arterial pulse points.

Part 3

Priority Action Approach to the Critically Ill Patients

Initial evaluation of the trauma patient

Most people will passively acquire some level of basic first aid knowledge and skills as they go through life, such as knowing that cool water feels good on a burn, and how to use an adhesive bandage. The difference between that which is learned passively and knowing how to provide effective, lifesaving first aid interventions requires instruction, practical training and frequent practice. While some industries are inherently more dangerous than others, this is especially true for hazardous and remote workplaces.

This chapter will be very important to the workplace attendant. It is arguably the most important information they will learn in first aid training. It is the foundation of occupational first aid. All of the following chapters in this manual will be based on the priority action approach. All first aid interventions branch off from these basic step-by-step procedures. For this reason, the priority action approach, introduced in this chapter, is referenced throughout the rest of the manual.

In this chapter, we start with some history and an overview of occupational first aid, followed by an introduction to the role of the attendant and an introduction to the priority action approach. The chapters that follow will expand on each element of the priority action approach in detail, including but not limited to teaching each critical intervention that may be necessary during the initial evaluation of a trauma patient. Wherever the attendant is likely to encounter a critically ill or injured patient, the procedures follow the priority action approach.

History of occupational first aid

The leading cause of death and impairment in adults aged 21 to 44 is major trauma. Trauma occurs when enough energy is applied to the body to cause injury. Major trauma occurs when the energy absorbed by the body is sufficient to create life- or limb-threatening injuries.

The care of trauma patients has evolved greatly from military experience. NATO missions in both Afghanistan and Iraq have shown that using skilled paramedics at the battle scene and rapid helicopter transport to specifically designed field hospitals saves many lives and limbs.

These methods have also been introduced into civilian life. As a consequence of more skillful first aid, as well as ambulance paramedic crews and air evacuation by helicopter and airplane, hospitals designated as trauma centres, care to the severely injured, and have improved markedly. The lead Emergency Medical Services agency in British Columbia is the BC Emergency Health Services (BCEHS). BCEHS paramedics in both ground and air ambulances, dispatchers, and staff provide a valuable service by arranging transportation for injured workers to hospitals across B.C. When a attendant determines that rapid transportation to a trauma hospital is in the best interest of the patient, the attendant should inform BCEHS without delay. Studies have confirmed that rapid transport and access to a trauma hospital significantly improve outcomes.

Introduction to the first aid attendant and the priority action approach

The critical role of the attendant is as follows:

- Recognize the seriously injured worker quickly.
- Perform lifesaving first aid interventions quickly.
- Activate and inform transportation BCEHS resources.
- Ensure that the patient gets to the hospital without delay.

The attendant is the initial and critical link in the chain of workplace trauma care. Activating the emergency response system to quickly get patients to hospital is very important for the trauma patient. The attendant is responsible not only for providing adequate care to the injured, but also for ensuring that there are no unnecessary delays in the transport to a medical facility.

How does the attendant handle the dilemma of performing a thorough yet rapid assessment? The solution is to use the priority action approach to patient assessment and apply the set of rapid transport criteria to determine whether an injured person has to be transported to hospital without delay or can be assessed and treated further in the field.

Patients whose mechanism of injury places them in the rapid transport category (RTC) require prompt, definitive treatment in hospital. The patient must be rapidly transported, with only essential treatment done at the scene. This essential treatment is referred to as critical interventions:

- Airway with C-spine control
- Clear an obstructed airway and maintain the airway (while protecting the cervical spine if necessary)
- Breathing
- Ventilate using a pocket mask
- Provide oxygen if indicated
- Circulation
- Start cardiopulmonary resuscitation (CPR) and ask for an automated external defibrillator (AED) if cardiac arrest has occurred
- Control life-threatening hemorrhage
- Rapid transport packaging
- Restrict spinal motion if spinal trauma is suspected
- Apply a hard collar if cervical spinal trauma is suspected
- Secure the patient to a carrying device/stretcher
- Provide limited immobilization for major or open fractures or dislocations

As soon as it's determined that the patient is in the rapid transport category, call for help. Follow the workplace emergency response procedures. Send someone to ensure that transportation/BCEHS resources have been informed and are activated.

Priority action approach

To get the patient into medical hands quickly, the attendant must develop the skills to assess and treat every patient in a rapid, systematic, and orderly manner. The priority action approach is the backbone of these skills.

Three "truths" provide the rationale for the priority action approach:

- First aid trauma care requires efficient use of time, so that the patient is transported to hospital as quickly as possible.
- When trauma patients die, it is often because they do not make it to the operating room in time.
- Major trauma patients cannot be stabilized in the field. Although splinting and bandaging are helpful for most patients, only lifesaving critical interventions are necessary in the pre-hospital environment for most major trauma patients.

Non-essential treatments consume valuable minutes, prolonging the time before lifesaving definitive care can be delivered.

Preparation before the emergency occurs

As the first caregiver on the scene, the attendant's judgment and speed can often determine the fate of the patient. The injured worker's chance of survival is maximized when the attendant has done their homework before an incident occurs.

It is strongly recommended that each attendant develop written procedures that include the following essential preparatory elements:

- Know your workplace and work environment. First aid cannot be provided if the patient cannot be found. It is important to know all the ins and outs of the workplace environment. Establish predetermined evacuation routes if some locations are difficult to extricate a stretcher from.
- Know how to get help quickly. Before an accident happens, identify other workers with first aid experience or train some co-workers on each shift to assist you in the event of an emergency. Know how to contact the ambulance or helicopter service as well as the local hospital. Keep emergency phone numbers and written evacuation procedures adjacent to all phones, including radio and satellite telephones, for quick reference.
- Review the workplace emergency response procedures. Every workplace must have posted written procedures for providing first aid. These procedures must include:
  - The equipment, supplies, facilities, attendants, and services available
  - The location of and how to call for first aid
  - How the attendant is to respond to a call for first aid
  - The authority of the attendant over the injured workers and the responsibility of the employer to report injuries to WorkSafeBC
  - Who is to call for transportation for the injured worker, and the method of transportation and communication with BCEHS resources
  - Prearranged routes in and out of the workplace and to medical treatment; a map and/or GPS coordinates may be required

These procedures should outline, in detail, what is to happen when an emergency occurs at the workplace. Usually there will be separate procedures for minor injuries versus serious injuries where the patient is not mobile.

The procedures for transportation of the patient with serious injuries may range from calling the local ambulance service or using the company emergency transport vehicle (ETV) or industrial ambulance to meeting British Columbia Emergency Health Services (BCEHS) at a prearranged spot along the transportation route or arranging for helicopter or other aircraft transportation. Transportation is described in Part 16, Chapter 50, starting on page 347.

The workplace emergency response procedures for transportation should be activated as soon as the attendant determines that the patient requires stretcher transport to medical aid and must include informing BCEHS. This would be indicated if the patient is unwilling or unable to get up when the attendant arrives at the incident site or may be determined during assessments conducted throughout the priority action approach.

- Pre-train workers on how to:
  - Provide assistance in first aid procedures
  - Get other helpers and first aid equipment
  - Contact the workplace emergency medical help and/or BCEHS
- Hold information and training sessions with co-workers so they understand the key information you require when the first call for help is received. This includes:
  - The exact location of the patients and the
  - best route to get there. This may require GPS coordinates and/or a map.
  - What happened?
  - How many patients are there?
  - Whether the patients are accessible and, if not, what is needed to get to them.
  - Scene dangers.
  - Special equipment and/or personnel required.
  - Whether the patients can be evacuated from the site by car, truck, or helicopter.
  - Whether someone will be there to direct you to the site.

With this essential information, the attendant can mentally prepare for the scene as well as assign co-workers to get specialized equipment (e.g., breathing apparatus, jaws of life, mobile crane).

- Ensure that essential equipment is ready and available. All essential equipment must be brought to the scene by the attendant or co-workers to save precious time and running back and forth. All equipment necessary for the priority action approach must be maintained in a state of readiness so it can be easily identified and brought to the incident site by the attendant or helpers. Essential equipment includes:
  - Oxygen and airway equipment and a suction device
  - First aid kit appropriate for the workplace
  - Hard cervical spine collars
  - Long spine board with straps
  - Lifting device such as a scoop-style stretcher
  - Basket stretcher or another suitable well-padded carrying device with securing straps

It is essential that first aid equipment be checked and maintained regularly. An injured worker may die if the first aid equipment is inoperable when needed.

- Attempt to survey co-workers for pertinent medical information that may be relevant during an emergency (medications, significant illnesses, and allergies), explaining to them that if they have any medical conditions or are taking medications, this information may be vital to their care. Reassure co-workers that providing the information is voluntary on their part and that any information will be kept strictly confidential. Confidential medical information must not be discussed with anyone other than medical personnel involved in the patient's care.
- Be prepared; think ahead.

Communication

Communication and personal interaction with the patient, bystanders, and co-workers are an essential part of first aid. How the attendant communicates and interacts with the patient, helpers, or medical aid may greatly influence the effectiveness of first aid.

Good communication and personal interaction skills

- Be calm and reassuring. Tell the patient that you are a trained attendant and that you are there to help. Nothing will reassure the patient more than if you can tell your patient that you, and your team, are prepared and have practiced for these types of events.

- Use the patient's name and establish personal interaction by looking them straight in the eye.
- Use language that the patient can understand and always speak clearly and slowly. Explain what you are going to do and reassure the patient as you carry out each procedure. Do this even if the patient is confused or comatose.
- Providing there is no immediate life-threatening condition, allow enough time for the patient to respond to your questions. Injuries or illness, or consequent emotional stress, can cloud the patient's thinking so that they need more time to respond, even to simple questions.
- Tell the truth. Otherwise, you will destroy the patient's trust in you. You may not tell the patient everything, but generally, a direct specific question deserves a direct, specific answer, given to the best of your ability and training.
- Use appropriate body language. This includes good eye contact and a non-threatening posture. A reassuring pat on the hand or shoulder will often go a long way to calm the anxious patient.
- Avoid being coldly detached or becoming angry or irritated with the patient. Keep your own emotions under control.

Communication with the patient

The attendant must alternately speak and carefully listen to the patient. The objective is to have the patient both understand what the attendant is doing and feel emotionally supported. This can greatly help the patient's condition, especially with shock, which is worsened by fear and agitation. Reassurance must be provided to the patient regardless of their level of consciousness.

The attendant should talk to the patient frequently, explaining procedures in advance when the patient's help or co-operation is required or movements are to be avoided. The attendant must also tell the patient if a required procedure may be painful (e.g., movement of an injured limb) and explain why it is necessary. This can help eliminate unpleasant surprises for the patient and reduce aggravation of existing injuries when moving parts of the patient's body where pain might be felt or resistance met.

Communication with helpers

The scene of an incident is very stressful for helpers and bystanders. A calm, reassuring, and positive attitude on the part of the attendant will help to relax helpers and gain their co-operation. The attendant must give clear and concise directions to the helpers regarding:

- Assisting in ongoing first aid procedures
- Controlling the scene (e.g., traffic control, de-energizing and lockout of equipment)
- Bringing required equipment
- Summoning medical aid (e.g., BCEHS, an emergency transport vehicle, industrial ambulance and/or helicopter)

Often the attendant will direct a helper to call BCEHS and request them to either come to the scene of the incident or to rendezvous with the company transport vehicle at a designated spot along the route to a hospital. How much information is given to this helper will depend on the following factors:

- How much information the attendant has obtained. There will be much less information available if the helper is dispatched during the scene assessment than during the head-to-toe examination.
- How much time the attendant can spend informing the helper. The attendant will be very busy during the primary survey.
- The attendant's opinion of the helper's capability to understand and retain information.
- The dispatched helper must have at least the following information to relay to the BCEHS dispatch:
  - The number of patients
  - The precise location of the patients (this may require GPS coordinates and/or a map)
  - The basic nature of the injuries or illnesses

Communication with Medical Aid

The attendant will be required to transfer the patient to the next level of medical care. This could be BCEHS ambulance paramedics or medical staff in hospital emergency departments. The attendant must provide patient information to this next level of care. See page 350, Transfer of Patient Responsibility, for a list of the information required

Initial assessment of the injured worker

The initial assessment of the injured worker follows the Priority Action Approach — a step-by-step procedure to follow. The Priority Action Approach is divided into the following four stages:

1. Scene assessment
2. Primary survey and critical interventions
3. Transport decision
4. Secondary survey

Scene assessment

The scene assessment is an evaluation of the incident site performed while approaching the scene. Vital information must be acquired. The attendant must:

- Assess the scene for hazards
- Determine the mechanism of injury
- Count the number of patients

During the scene assessment it may be obvious which mode of emergency transportation will be needed (e.g., company ambulance, the BCEHS or local ambulance service, water or air transport). To save valuable time, the attendant may elect to summon emergency transportation, which can later be cancelled or downgraded.

Hazards

Remember to check the scene for hazards. Do not become a patient yourself!

Ensure the scene is safe for you and the patient (see Figure 3-1 Ensure the scene is safe for you and the patient). Are wires down? Are toxic gases present? Is there a risk of explosion or fire? Immediately determine whether special equipment and/or personnel are required (e.g., self-contained breathing apparatus, mechanic, electrician). Decide if the patient must be extracted because of such hazards or environmental extremes (e.g., very hot, cold, or wet environments).

Figure 3-1 Ensure the scene is safe for you and the patient

Do not proceed with patient assessment if it exposes you and/or the patient to further risk. Quickly move the patient to a safe environment and then perform the primary survey

Mechanism of injury

Many life-threatening injuries are not initially apparent. Understanding the mechanism of injury can often help in predicting underlying serious injury. In general, injuries result from the transfer of energy to all or a part of the body. For example, if a person falls onto soft ground, the soft ground absorbs some of the energy of the fall, less energy is transferred to the body, and the likelihood of injury is less than if the person falls onto a hard surface such as concrete.

To determine how the mechanism of injury may have affected the patient, the attendant should try to answer the following questions at every incident scene:

- What happened?
- How much energy was applied to the patient?
- To what part of the body and in what direction was the energy applied?

For example, a fall from 2 m (6 ft.) would not cause as significant an injury as a fall from 10 m (30 ft.). The velocity gained by falling the extra distance from 10 m (30 ft.) causes considerably more energy to be transferred to the body. Every organ of the body has a particular energy limit above which injury will occur. If sufficient energy is applied to a ligament or bone, it will snap or break.

Research shows that certain types of accidents have a higher risk of serious internal organ injury. Because these injuries are often not obvious, the attendant must use the mechanism of injury to raise their suspicion that the patient has a serious injury. Patients with potentially serious injuries, based on the mechanism of injury, must be rapidly transported to hospital. Table 3-1 lists mechanisms of injury that require rapid transport to hospital

Number of patients

The final step in the scene assessment is to determine the number of patients. Are all persons involved accounted for? Ask witnesses. Ask the conscious patient. If there is more than one patient, get help immediately. Do not try to do it all. It is very difficult for one attendant to manage more than one critical patient at a time. Where there are multiple patients, some may have to be transported to hospital without full assessments being completed. The attendant must be more concerned about getting all the patients transported to medical care than about doing a full assessment on one patient and leaving the others. When there are multiple patients, it is essential for the attendant in charge to prioritize patients for transport. The multi-patient scenario is dealt with in more detail in Chapter 39, Multiple Casualties, Disaster, and Triage.

Mechanisms of Injury Requiring Rapid Transport to Hospital

- Free fall from a height greater than 6.5 m (20 ft.)
- Severe deceleration in a motor vehicle accident as evidenced by:
  - high-speed accident and/or major vehicular damage
  - broken windshield, bent steering wheel, or significant damage to the passenger area
  - occupant thrown from vehicle
  - one or more vehicle occupants killed
  - roll-over type of accident — e.g., with a forklift
- pedestrian, motorcyclist, or bicyclist struck at a speed of greater than 30 km/h (20 mph)
- severe crush injuries
- smoke or toxic-gas inhalation, or carbon monoxide poisoning (see page 302)
- decompression illness (see page 294)
- Near-drowning (see page 292)
- Electrical injuries (see page 284)

Table 3-1

Summary

Scene assessment accomplishes the following goals:

- determining the presence of hazards to the attendant and the patient
- establishing the mechanism of injury
- determining the number of patients

The information gained from the scene assessment allows the attendant to make some immediate transport decisions. It also provides the basis for patient assessment.

Primary survey

The second stage of the priority action approach is the primary survey. It begins immediately after the scene assessment. Even if the patient is trapped and extraction is in progress, first aid must be initiated, beginning with the primary survey. The primary survey is a rapid patient assessment to determine the presence of any immediate life-threatening injuries or conditions. The assessment itself should not take more than two minutes and is only interrupted to correct any life threatening conditions identified.

The initial part of the primary survey is accomplished on first contact with the patient. The attendant must determine if the patient is in cardiac arrest. Whether the patient is responsive or not determines the next sequence of events. If the patient is unresponsive and not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest. In this situation CPR/AED is initiated according to Part 5, Chapter 13.

If the patient has some level of response (see Table 3-2), the primary survey is conducted in a rapid step-by-step manner. Each step must be completed before going on to the next. The primary survey is based on assessment of the ABCs.

A = airway (with C-spine control if necessary)
B = breathing
C = circulation

During the assessment, the only interventions performed are for such life-threatening conditions as:

- cardiac arrest
- airway obstruction
- severe respiratory distress
- severe bleeding

A for airway

The attendant's number-one priority is to establish and maintain an open passage for air to enter and leave the lungs. The inability to recognize, or failure to treat, an unstable airway may be fatal. At the same time, managing the airway must not unnecessarily aggravate injuries that may be present in the neck. The mishandling of the neck in an associated cervical spine injury may cause permanent damage to the spinal cord and render the patient quadriplegic. Consequently, in describing the airway management in trauma patients with suspected cervical spine (C-spine) injuries, airway with C-spine control is always emphasized.

Approach the patient from the front, if possible. Briefly identify yourself in a reassuring manner (e.g., "I'm a first aid attendant. I'm here to help you and get you to medical aid as quickly as possible. What happened?"). The patient's response provides immediate crucial information about their level of consciousness and airway status. If the patient speaks clearly, then the airway is clear and the attendant should proceed to the next step. If the patient does not respond to your voice or to a pain stimulus, the attendant must open the airway using either a head-tilt chin-lift (non-spinal trauma) or a jaw thrust (suspected spinal trauma) and assess for air movement

Level of Consciousness on Approach — AVPU

Many attendants use the AVPU system to determine the level of consciousness of the patient on approach.

A — Alert

Patient is aware of surroundings, time, date, and name.

V — Verbal

Patient is disoriented but responds when spoken to, may not have spontaneous eye opening but will open eyes to verbal stimulus.

P — Pain

Patient does not respond to questions, but moves or cries out in response to painful stimulus.

U — Unresponsive

The patient does not respond to any stimuli.

Table 3-2

If the mechanism of injury suggests spinal trauma, manually stabilize the head and neck. Do this by approaching the patient from the top of their head, firmly placing your hands over their ears and stabilizing the hold by placing both your elbows on the ground if possible (see Figure 3-2a, C-spine supine).

Realign the head and neck. Do not apply significant force when realigning the patient's head and neck to anatomical and neutral. The neck should realign with minimal effort — if force is required, maintain in position found. This position stabilizes the head and neck and also allows the attendant to readily perform a jaw thrust manoeuvre (see page 54, Jaw Thrust) to open the patient's airway if necessary. This stabilizing procedure can easily be shown and explained to an untrained helper when handing off the C-spine control. Trauma patients with the following injuries must be assumed to have an associated cervical spine injury and the airway must be managed with proper C-spine control:

- Head injuries, with or without decreased level of consciousness
- Multiple-system injury
- Injuries whose mechanism of injury suggests spinal trauma

Positioning the patient for the primary survey

The techniques for positioning injured patients with suspected spinal injuries are described on page 146, Techniques for Moving Patients with Spinal Injuries.

Supine position

The primary survey and all subsequent assessments are best done with the patient in the supine position (lying flat on their back, facing upward). Supine is the best position to assess the airway, breathing, and level of consciousness, as well as to perform most critical interventions.

Prone position

The attendant may conduct the primary survey in the position found, provided critical interventions are not required. If the attendant cannot perform the primary survey in the position found, position the patient lateral to assess the airway. If the airway is clear, the patient is rolled supine to complete the primary survey.

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Attendant alone — conscious, prone trauma patient

If the attendant is alone and the patient is found prone or ¾-prone (partially face down on their side), the primary survey may be completed in the position found, provided critical interventions are not required. The patient can then be repositioned when help arrives. If the patient has a decreased level of consciousness and the attendant cannot establish the ABCs in the position found or requires critical interventions, the attendant must provide limited support for the head and neck and quickly roll the patient supine using the single-person log-roll.

Figure 3-2a C-spine supine

Figure 3-2b C-spine prone

Airway assessment

IIn the multi-system, head and/or spinal trauma patient, the attendant manually stabilizes the head and neck; then, if the patient is unresponsive, the attendant opens the airway (see Figure 3-2a C-spine supine) and assesses the movement of air in and out of the mouth and nose. If the patient is not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, the attendant will initiate CPR/AED according to Part 5, Chapter 13.

Before the attendant performs critical interventions of the airway or completes the primary survey on the patient who is not in cardiac arrest, C-spine control must be handed off to a helper. The attendant must give the helper clear instructions and frequently monitor the helper to ensure that the patient's head and neck are being adequately stabilized.

If an obstructed or partially obstructed airway is suspected, it must be cleared before proceeding with the primary survey. The jaw thrust is the best manoeuvre that should be used to open the airway if the mechanism of injury suggests head and/or spinal trauma. Because maintaining a patent airway is a priority during CPR, if the jaw thrust does not adequately open the airway, it may be necessary to extend the patient's head and neck. An oral airway may have to be inserted (see page 55, Oral Airway). Assisted ventilation with a pocket mask and oxygen may be required (see page 60).

All patients with persistent, partial (mild) or complete (severe) airway obstruction are in the rapid transport category.

The secondary survey and further treatment are performed en route to medical aid or while awaiting transport.

The patient with a decreased level of consciousness must never be left unattended in the supine position as the airway may become obstructed by the tongue, vomitus, or blood.

B for breathing

The second essential step in the primary survey is to assess the patient's breathing or respiration. If the patient is unresponsive and not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, the attendant will initiate CPR/AED according to Part 5, Chapter 13.

The following is an overview of the breathing assessment and treatment. More detailed discussion of the various conditions that impair breathing in the trauma patient begins on page 53.

Adequate breathing is essential if the body's organs, particularly the heart and brain, are to receive enough life-sustaining oxygen and have carbon dioxide removed.

The attendant will be concerned with three breathing states

1. Agonal/absent
2. Slow, shallow, inadequate
3. Appropriate rate/rhythm/tidal volume

The attendant can determine if breathing is adequate by assessing the patient's respirations and the quality of respiration. Both assessments are of equal importance.

The respiratory status is determined by talking to the patient. If the patient is responsive and can speak normally, the attendant may conclude that the patient is breathing adequately until a more detailed assessment can be made. If the patient is unresponsive, the attendant can look, listen, and feel for air movement to assess whether the patient is breathing normally (see Figure 3-3 Assess breathing).

Figure 3-3 Assess breathing

Agonal respirations are common with a cardiac arrest. An unresponsive patient with breathing that is sporadic, ineffective, intermittently gasping or unusual in nature is exhibiting agonal respirations and may be in cardiac arrest. If the attendant has any doubt whether the unresponsive patient with agonal respirations has a carotid pulse, the attendant should initiate CPR without delay. The benefits of performing CPR/AED outweigh the risks of cardiac arrest going unrecognized and potentially withholding CPR/AED. If the carotid pulse is present and the breathing is not effective (e.g., too slow, fast, shallow, laboured or patient is cyanotic) assisted ventilation using a pocket mask is required.

Of equal importance is the quality of breathing. If the patient is anxious and is having difficulty breathing, they will be experiencing shortness of breath (dyspnea). The patient's chest may have to be exposed to assess the adequacy of breathing. This is usually done during the rapid body survey; however, it may be necessary to do this during the breathing assessment.

Exposure of the chest allows the attendant to discover any evidence of chest wounds, to observe chest wall movements, and to assess the adequacy of breathing. Both sides and the back of the chest must be included in the assessment. When exposing the chest, the attendant should provide for both the patient's dignity and the weather conditions. The attendant must expose the patient's chest if:

- Respiration is inadequate
- There has been trauma to the chest

Patients with severe respiratory distress will require assisted ventilation with oxygen. Refer to the criteria for assisted ventilation on page 60. Signs of severe respiratory distress include:

- Very slow and/or shallow, ineffective respiration with little chest wall movement
- Struggling, laboured, gasping respiration
- Use of accessory muscles of respiration
- Patient may exhibit panic and complain of feeling smothered

If the patient is struggling because of respiratory distress, they may resist the attendant's attempts to help with assisted ventilation despite reassurances. In this case, assisted ventilation using a pocket mask is stopped, and unless the attendant can quickly prove that the patient has normal oxygen saturations, supplemental oxygen is provided. Blood oxygen levels in humans without impaired respiratory function are considered normal when it is between 95 and 100% when measured using a pulse oximeter. If the patient will not tolerate an oxygen mask on their face, the patient may tolerate a nasal cannula or a simple oxygen mask placed as close to their breathing zone as possible. If the patient loses consciousness, assisted ventilation using a pocket mask with oxygen is restarted. The various methods of assisting ventilation are described on page 60, Ventilation Techniques.

While providing assisted ventilation, the attendant must ensure that C-spine stabilization continues if the mechanism of injury suggests spinal trauma.

Patients with severe respiratory distress are in the rapid transport category. Complete the primary survey and critical interventions and transport rapidly to hospital. The secondary survey and all further treatment are performed en route to medical aid or while awaiting the ambulance.

C for circulation

The third and last step in the primary survey is an assessment for signs of shock, life-threatening bleeding, and obvious fractures. The following is an overview of the assessment and critical interventions for circulation. More details begin on page 96, Shock.

For the body's cells to receive an adequate supply of oxygen and have wastes removed, the heart must be beating and sufficient blood must be circulating. If the patient is unresponsive and not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, the attendant will initiate CPR/AED according to Part 5, Chapter 13.

The attendant must intervene as soon as possible if the patient is in shock or losing blood. The attendant must also discover obvious fractures and provide limited support to enable the patient to be moved with minimal discomfort if the patient is in the rapid transport category.

Assessment for circulation

In the primary survey, circulation is best assessed by feeling the patient's pulse. The pulse is a pressure wave generated by the heart when it contracts. It can usually be felt along the arteries that are closest to the skin. Satisfied that the patient is breathing effectively or breathing is being assisted, the attendant should check for the presence of a radial pulse. The attendant should use the fingers (see Figure 3-4 Assess radial pulse) and not the thumb to feel for the pulse to avoid confusing their own pulse with that of the patient.

Assessment for shock

With a healthy adult, loss of the radial pulse indicates a low systolic blood pressure. The actual numerical blood pressure is less important. If the attendant can feel the patient's radial pulse, the attendant will know that their systolic blood pressure is at least adequate to move arterial blood to the extremities. Accurately measuring blood pressure in the field unnecessarily uses precious minutes at the incident scene and delays transporting the patient to definitive care. The attendant should assess for the presence of a carotid pulse if they cannot find the patient's radial pulses.

Figure 3-4 Assess radial pulse

Generally, the pulse is assessed by noting its rate, strength, and regularity. However, for purposes of the primary survey, only the presence or absence of the radial pulse is crucial.

In rare cases, loss of the radial pulse is related to direct vessel injury of the upper extremity or may be the result of a previous injury to that extremity. For example, a displaced fracture of the elbow may injure the artery in the arm. This can result in loss of the radial pulse on the injured side and does not necessarily indicate shock. Therefore, it is important that when presented with a non-palpable radial pulse on the wrist nearest the attendant, they must examine the opposite wrist for the presence of a pulse.

The attendant then looks for other signs and symptoms of shock, such as cool, pale, and clammy skin, by feeling the patient's skin with the back of their gloved hand. Shock signs in a trauma patient are usually associated with significant blood and/orfluid loss.

Any patient in shock is in the rapid transport category.

Complete the primary survey and critical interventions, and transport rapidly to hospital. The patient in shock requires gentle handling and, if indicated, C-spine stabilization. The secondary survey and all further treatment must be performed en route to medical aid or while awaiting transport.

Rapid body survey

Within the primary survey it is necessary only to detect critical emergencies. Life-threatening external hemorrhage (major bleeding) needs to be controlled as soon as possible with direct pressure on the wounds, bandages, and/or tourniquets.

Assessment of circulation is continued by performing a rapid body survey. Look for hidden, massive external hemorrhage and obvious fractures and ask the patient about neurological deficits that would require ongoing spinal motion restriction protocols (see Figure 3-5 Conduct a rapid body survey). If there is massive external hemorrhage, the site will have to be exposed (e.g., by cutting away heavy outer clothing and/or rain gear) for the bleeding to be controlled.

Figure 3-5 Conduct a rapid body survey

This rapid body survey should not take the attendant longer than 30 seconds and is interrupted only to control massive bleeding support unstable fractures and/or penetrating objects and initiate cooling. The attendant quickly but carefully feels all areas of the patient's body and looks/feels for pools of blood (especially under the patient or in the body hollows), and checks for major deformities. During this survey the attendant must be alert for sharp tools, debris, or needles that could be hidden in the patient's clothing or pockets. The attendant must initiate any required critical interventions discovered during the rapid body survey (see Figure 3-6 Priority action approach and critical interventions). During the rapid body survey, the attendant should consider the modified NEXUS rule (see Fig 3-11) and ask the patient about any posterior midline neck pain and any numbness, tingling or weakness in their extremities. This should be done quickly but gently. The intent of the questions are to rule out the need for ongoing full spinal motion restriction if possible. Helpers available at the scene should be asked to wear nitrile gloves and be shown how they may help the attendant (e.g., be shown where to apply pressure or how to support a limb).

During the rapid body survey, the attendant may discover injuries or conditions that place the patient in the rapid transport category (RTC). These conditions are listed on page 30.

ABC reassessments

When the primary survey is completed, all patients must have their ABCs re-evaluated by the attendant at regular intervals. The reassessment ensures that deterioration has not occurred and that critical interventions continue to be effective. This will also ensure that helpers working under the attendant's direction are carrying out their assigned duties effectively — e.g., maintaining assisted ventilations, supporting wounds/fractures, etc. This ABC reassessment must include a bandage and tourniquet check for rebleeding at major bleeding sites

The ABCs are reassessed every:

- 5 minutes for RTC patients
- 10 minutes for non-RTC patients
- 5 minutes for the urban attendant with a patient requiring transport by BCEHS resources

It is imperative to reassess the patient frequently because a patient who initially appears to be stable may deteriorate quickly. Such a patient must be upgraded to the Rapid Transport Category and, if an ambulance was dispatched, BC EHS must be updated regarding changes in the patient's condition.

Priority action approach and critical interventions

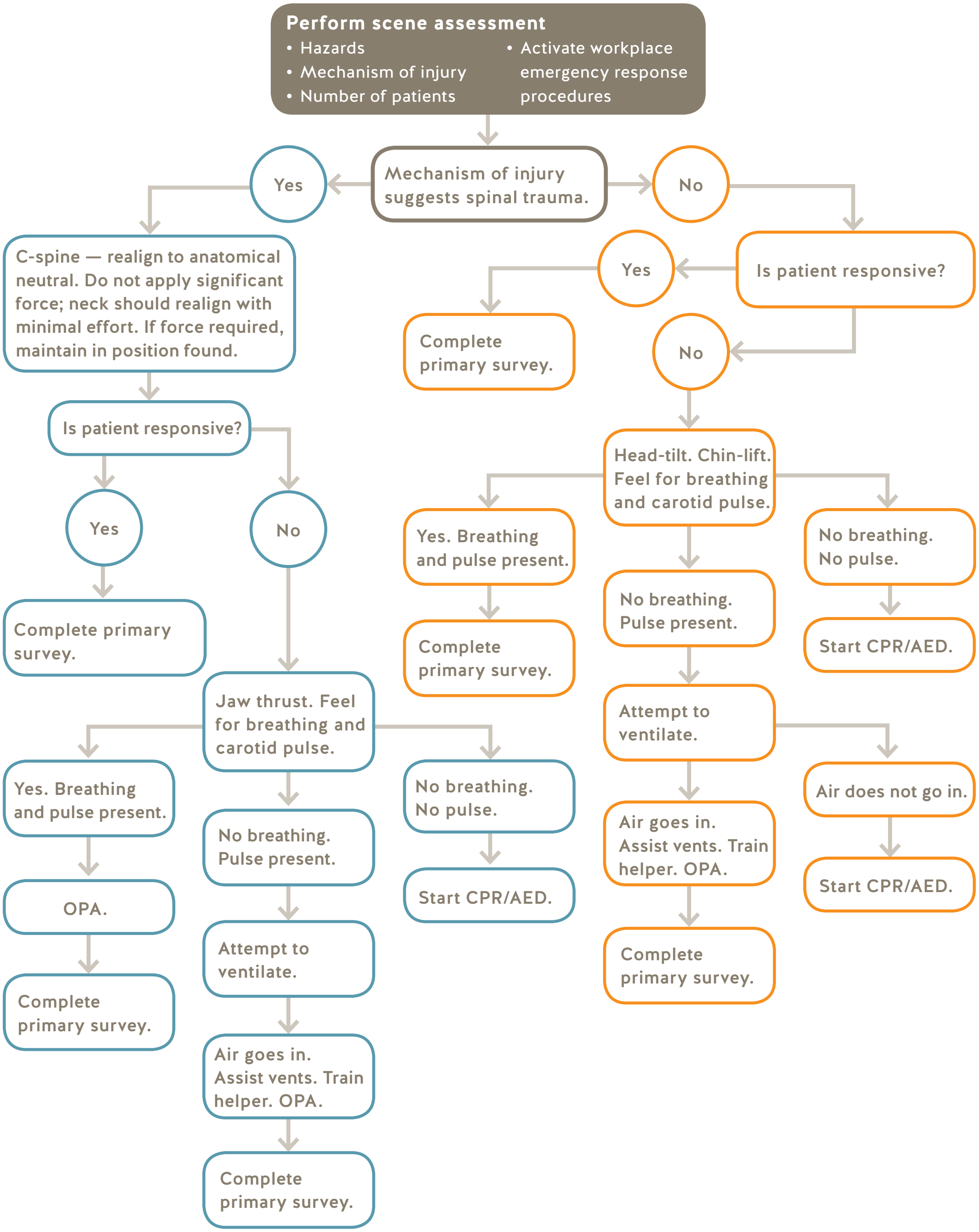

Figure 3-6 Priority action approach and critical interventions

Rapid transport criteria

To ensure that seriously injured patients are transported to hospital as soon as possible, the rapid transport criteria have been developed. Trauma specialists have developed this list of criteria and it is used throughout North America. These criteria help the attendant determine which patients must be transported with great haste. The following criteria must be memorized and carried with the attendant at all times for handy reference.

Whether a patient meets the criteria can be established by considering:

- Mechanism of injury
- Anatomy of injury
- Findings in the primary survey

Mechanism of injury

- Free fall from a height greater than 6.5 m (20 ft.)
- Severe deceleration in a motor vehicle incident characterized by:
  - High-speed incident and/or major vehicular damage
  - Broken windshield, bent steering wheel, or significant damage to the passenger compartment
  - Occupant thrown from vehicle
  - One or more vehicle occupants killed
  - Rollover type of incident — e.g., with a forklift
- Pedestrian, motorcyclist, or bicyclist struck at greater than 30 km/h (20 mph)
- Severe crush injuries
- Smoke or toxic-gas inhalation, or carbon monoxide poisoning (see page 302, Carbon Monoxide)
- Decompression illness (see page 294, Decompression Illness)
- Drowning (see page 292, Water and Diving Emergencies)
- Electrical injuries (see page 284, True Electrical Injuries)

Anatomy of Injury

- Severe brain injury, defined as one or more of the following:
  - Glasgow Coma Score of 13 or less (see page 35, Glasgow Coma Scale)
  - Pupillary inequality greater than 1 mm and sluggish response to light with altered level of consciousness (see page 36, Pupils)
  - Depressed skull fracture (see page 126, Skull Fractures)
- Penetrating injury to the head, neck, chest, abdomen, or groin
- Pelvic fracture (see page 258 Pelvic Fractures)
- Two or more proximal long-bone fractures — e.g., femur, humerus
- Flail chest (see page 66, Flail Chest)
- Pregnant person with significant trauma — e.g., a limb fracture, or chest or abdominal trauma
- Burns:
  - Inhalation injury (see page 72, Smoke Inhalation)
  - Extensive facial burns
  - Electrical burns
  - Second-degree (partial thickness) burns to more than 10% of the body surface (see page 277, Second-Degree Burns)
  - Third-degree (full thickness) burns to more than 2% of the body surface (see page 278, Third-Degree Burns)
  - Burns encircling a limb
  - Major burns to the hands, feet, or genitalia
  - Chemical burns
- Amputation of an extremity other than a toe or finger
- Spinal-cord injury, paraplegia or quadriplegia (see page 141, Spinal-Cord Injury)
- Penetrating eye injuries (see page 168, Foreign Bodies)

Findings in the primary survey

- Decreased level of consciousness (does not respond with clear speech)
- Partial or complete airway obstruction
- Any condition requiring assisted ventilation
- Cardiac arrest
- Suspected heart attack
- Obvious circulatory shock (see page 98, Hypovolemic Shock)
- Bleeding requiring the application of a tourniquet
- Acute poisoning, if directed by Poison Control Centre
- Status epilepticus (see page 134, Seizure disorders)
- Stroke
- (see page 132, Non-traumatic Brain Injury: Stroke)
- Anaphylactic reaction (see page 100, Anaphylactic Shock)
- Moderate or severe hypothermia (see page 273, Hypothermia)
- Heatstroke (see page 270, Heatstroke)

If the patient meets any of the preceding criteria, rapid transport is required. Any treatment prior to packaging should be limited to critical interventions.

Be sure to activate BCEHS early, and provide as full a description of the event and the findings of the patient as possible. Have a high degree of suspicion for high-energy mechanisms, and a high degree of suspicion for internal injuries. The ambulance service sends different resources based on information provided in your call. If you find new information after your first call to BCEHS that you think is important, contact BCEHS again to provide an update. In remote or inaccessible areas, transportation may require a medical air evacuation. Important considerations and guidelines specifically for medical air evacuations are found on page 352, Air Evacuation.

Patient packaging for rapid transport

From the moment it is decided that a patient must be rapidly transported to hospital, only critical interventions should be performed. All other efforts must be directed at preparing the patient for safe transport as rapidly as possible.

If, during the primary survey, it is determined that the patient is in the rapid transport category, the attendant must only do the following:

- Carry out critical interventions for problems with the airway, breathing, and circulation.
- Complete the primary survey.
- Apply the modified NEXUS rule (when appropriate).
- Quickly prepare for rapid transport by packaging the patient.
- Reassess the patient's ABCs

The primary survey, critical interventions, apply the modified NEXUS rule and patient packaging should be completed in less than 15 minutes. Rapid, safe transport is the priority.

The attendant should immediately begin packaging the patient and direct others to arrange for appropriate transportation and/or additional resources. The secondary survey should be conducted after the patient is packaged and en route to hospital or while the patient is waiting for the transport vehicle.

Packaging a patient for rapid transport means the patient becomes protected from further injury by being supported by and secured to a well-padded stretcher. In the past, the management of trauma patients included the use of a long spine board and thorough immobilization. Research conducted over the last several years suggests that not all trauma patients benefit from full immobilization. The risks of fully immobilizing may outweigh the benefits. The application of a cervical collar and fully immobilizing an injured patient on a spine board may adversely affect airway and breathing management. The application of a hard collar may contribute to increased intra-cerebral pressure. The long spine board is an extrication device; it allows transfer of a patient to a transport stretcher. The use of a long spine board is not required to achieve spinal motion restriction. The key is to restrict movement of potentially injured body parts. Although the risk of secondary injury — e.g., spinal injury after the initial trauma is over — is very rare, if it does occur the consequences may be devastating.

Supporting the cervical spine in a comfortable manner is important. It should be noted that during the writing of this reference and training manual, the current literature has had considerable debate about the best method to support the spine and safely assist in extraction. Use the tools described below to provide the most secure and comfortable support for the injured patient.

The long spine board is the lifting device commonly available throughout industry. It should only be used for extraction purposes and not for transportation. If available, a clamshell or scoop-style stretcher (see Figure 3-7a) or other appropriate stretcher with restraints may be the best device to use to move the patient on to an appropriate stretcher.

Figure 3-7a Scoop-style stretcher

The term patient packaging is used so that the attendant will think of the patient as a fragile, priceless article that must be shipped some distance and may be exposed to inadvertent rough handling and/or moved through all manner of positions. For example, in transit, the patient may be exposed to the shaking and thumping of a rough service road while in a transport vehicle or to air turbulence in an air evacuation. If vomiting occurs, the patient may also have to be rapidly turned as a unit into the lateral position to protect the airway, or the stretcher may have to be manipulated to get it into an aircraft. For the patient with multiple trauma and suspected C-spine injury that the attendant cannot rule out, it is imperative that the patient be adequately secured, with appropriate padding, to a well-padded basket stretcher (see Figure 3-7b) so that patient movement is restricted and associated injuries are protected and not aggravated.

Figure 3-7b Well-padded basket stretcher

Once the patient is placed in the rapid transport category, the techniques used for patient packaging for rapid transport supersede and replace all other immobilization and splinting techniques contained in this reference and training manual. The attendant must focus on reducing scene time and ensure precious minutes are used only to do that which is necessary at the scene. The priority is to conduct necessary critical interventions only and get the patient packaged and en route to medical aid as quickly as practicable.

Advantages of rapid transport patient packaging

- The patient is rapidly prepared for transport.
- It is easier to manage the patient's airway while protecting their cervical spine.
- The method affords some chest-wall stabilization for associated chest injuries.
- Other injuries are effectively secured, reducing their aggravation — e.g., spinal injuries, pelvic fractures, lower-limb fractures.
- The patient is protected from further injury en route.
- The delirious or combative patient is effectively controlled.

Equipment required for rapid transport packaging

- AA hard cervical collar of the appropriate size.
- A long spine board (may be needed for extraction).
- A scoop-style stretcher with securing straps
- A well-padded patient care transport stretcher.
- Straps: an adequate number of 2 m x 5 cm (6 ft. x 2 in.) heavy Velcro straps, spider straps, or safety-belt-type straps with quick-release buckles to secure the patient in the stretcher adequately.

  Straps should cross the chest, pelvis, and legs. The patient's head may also need to be supported and secured.

If a spine board is required to move the patient to the stretcher, straps are preferred. However, triangular bandages and/or 5 cm (2 in.) tape may be used. Tape may not stick in a wet or cold environment.

- An adequate number of regular blankets or
  - comparable padding. Blankets or padding should be placed: on the spine board or stretcher for extra padding under the patient and on each side of the head and neck if necessary
- Additional blankets or padding may be necessary
- to provide support to injured limbs. At least one blanket will be needed to cover the patient if necessary, depending on the weather.

Securing the patient for rapid transport

The attendant will have to quickly decide the best position and method of securing the patient to the stretcher. It will require the attendant to take into consideration the transport time, equipment available, the number of helpers available, the mechanism and anatomy of injury, and the findings in the primary survey. In some cases, the attendant will be able to rule out the need for spinal motion restriction and make the patient as comfortable as possible on the stretcher. In the case of a multi-system trauma or suspected spinal-trauma patient, the attendant will have to move the patient carefully but quickly while attempting to restrict movement of the patient's spine. The attendant should instruct the alert, co- operative patient to minimize movement (self-immobilize) while the attendant supports him or her during the transfer onto the stretcher. In the case of a suspected cervical spine–injured patient, the head and neck must be secured last. The head and neck must be maintained in the anatomical position manually or with suitable readily available materials while the rest of the packaging is applied.

The reason the head and neck are secured last is to avoid additional injury to the neck and head if there are any inadvertent movements before packaging is complete. Should there be movement, it is much easier to protect the head and neck and maintain alignment with the body if the head and neck are not yet secured. If any patient packaging process causes pain, reconsider whether there is another way to support the injury sufficiently that will not cause pain.

All strapping should line up on both sides and straps that criss-cross one another should cross over the midline anteriorly to allow rapid access to the patient for further assessment. It should be adequately secured so patient movement is gently restricted on the stretcher during transportation. If Velcro straps are used, it is recommended that the straps overlap one another at least 25 to 30 cm (10 to 12 in.) to ensure solid contact. It is important that the Velcro be applied fuzzy/looped side toward the patient. When the straps are secured to the stretcher, they should be twisted 180 degrees, tightened enough to restrict spinal motion when appropriate, and applied to themselves, fuzzy/looped side to hooked side.

While packaging the patient the attendant must regularly assess the airway, breathing, and circulation. The attendant may have to delegate packaging procedures to helpers while performing critical interventions — e.g., airway management, assisted ventilation, control of major hemorrhage. In such cases the attendant should intermittently supervise helpers from wherever they are working and then check all the strapping and padding once the critical interventions have been concluded or have been handed over to a competent helper.

If the attendant has delegated a critical intervention to a helper — e.g., assisted ventilation, it is essential that the attendant frequently recheck (every 5 minutes) — the effectiveness of the intervention. The attendant must not become so distracted with packaging or other activities that the patient's condition deteriorates without the attendant's knowledge.

The need to protect and/or maintain both airway with C-spine control and breathing is of the utmost importance. Unfortunately, this may lead to increased discomfort or potential aggravation of other injuries. For example, the patient may have to be rolled onto a fractured pelvis or a fractured femur in order to manage the airway effectively. However, maintenance of the airway with C-spine control, breathing, and circulation always take precedence over tending to other injuries.

Rapid transport packaging for a suspected spinal injured patient in the supine position

The multi-system trauma or suspected spinal-injured patient is positioned and secured on the stretcher in the supine position according to the protocols outlined in the chapter on Spinal Injury Management, beginning on page 146.

Rapid transport packaging for a suspected spinal-injured patient in the lateral position

The multi-system trauma or suspected spinal-injured patient is positioned and secured on the stretcher in the lateral position according to the protocols outlined in Chapter 18 (see page 146, Spinal Injury Management) .

The major indications for transporting the patient with suspected spinal injury in the lateral position are:

- Facial injuries with active bleeding in the upper airway
- Active vomiting
- A decreased level of consciousness that cannot be continuously monitored by the attendant
- Stretcher limitations — e.g., inability to rotate the stretcher should the patient vomit and suction is not available
- Helicopter evacuations (if the stretcher is suspended below the helicopter during rescue operations, a patient cannot be monitored effectively so the lateral position is required)

It is particularly important to carefully pad the stretcher and all parts of the patient that contact the stretcher whenever possible if transporting the patient in the lateral position.

Adequate padding will help prevent the formation of pressure sores (see page 157, Pressure Sores). More attention must be paid to filling in hollows and spaces, both anteriorly and posteriorly, to ensure patient movement is comfortably limited during transport.

The attendant must think ahead before moving the patient onto the stretcher in the lateral position. Patients positioned on the stretcher in the lateral position for transport must face the attendant when in the transport vehicle or craft.

Secondary survey

The purpose of the secondary survey is to perform a rapid but complete patient assessment.

The secondary survey is a more detailed assessment than the primary survey, but should not take longer than 10 minutes.

For a patient in the rapid transport category, the attendant will conduct the secondary survey en route to the hospital. If transport is not readily available for these patients, the attendant will package the patient and then conduct the secondary survey while awaiting transportation. For a patient who is not in the rapid transport category (non-RTC), this assessment should be conducted at the scene. The information gathered by the attendant during the secondary survey of a non-RTC patient will also help the attendant decide in which position the patient should be transported. Through careful assessments the attendant may be able to rule out the need for ongoing spinal precautions that could not be ruled out during the initial assessment.

If during the secondary survey a patient is upgraded to the rapid transport category, the attendant must:

- Stop the secondary survey
- Carry out critical interventions for problems with the airway, breathing, and circulation
- Ensure that BCEHS (911) is updated
- Quickly but carefully prepare the patient for rapid transport by packaging them according to information available at this point
- Apply the modified NEXUS rule if it was not applied at the end of the primary survey
- Reassess the patient's ABCs
- Continue the secondary survey at the scene only while awaiting transport (otherwise continue it en route to medical aid)

The secondary survey involves the following areas of assessment:

- Vital signs
- History taking:
  - Chief complaints and history of current injury or illness
  - Allergies
  - Medications
  - Past medical history
- Head-to-toe examination

Vital signs and history

Once the primary survey has been completed, the transport decision has been made and the patient is packaged if appropriate, the attendant should take and record the patient's vital signs, and history. The order of operations will depend on whether the patient is conscious or unconscious. In some cases it may make more sense to assess the history before the vitals are taken and recorded. The attendant will have to consider the mechanism of injury, the chief complaint and the findings in the primary survey to make this decision. The vital signs include assessment of:

- Respiration
- Oxygen saturation level
- Pulse
- Level of consciousness
- Pupils
- Skin

Taking the vital signs is not usually necessary for patients whose conditions are such that the attendant is likely to do the complete treatment. Vital signs need only be performed in these patients if:

- They are being sent to medical aid (or the attendant makes this recommendation but the patient refuses)
- They complain of some unusual symptoms (e.g., shortness of breath, light-headedness, nausea, fever, "I don't feel right")

Respiration and oxygen saturation

TThe rate and quality of respiration is the first component of the vital signs. Use a watch with a second hand; count the number of breaths taken in a 15-second interval, and then multiply that number by four to determine the number of breaths per minute. The significance of this assessment is discussed in the primary survey (see page 25, B for Breathing) as well in the respiratory section (starting on page 49).

Pulse oximetry

Pulse oximetry is a technology used to measure the oxygen level in blood. A finger pulse oximeter is equipped with technology to rapidly detect changes in the blood oxygen level. A pulse oximeter should always be used when it is anticipated that the patient will be on oxygen for an hour or more. To use a finger pulse oximeter, turn the device on and then clip it onto the patient's fingertip to get a blood oxygen reading. The blood oxygen saturation will help the attendant decide whether oxygen should be applied if it has not been, and/or to adjust the flow rate if appropriate. The attendant should maintain the patient's blood oxygen saturation above 95%.

Accurate oxygen measurements by oximetry require a good blood flow through the tissues. When the fingers are cold, blood flow is reduced and poor or abnormal readings are possible. Also, oximetry does not measure the carbon dioxide in blood. In the state of a severe breathing attack — e.g., bronchospasm such as in chronic obstructive pulmonary disease — it is possible to have a normal oxygen saturation level with severe carbon dioxide buildup (see Chapter 7 Oxygen Therapy and Equipment).

Pulse

The pulse is an important indicator of the status of the circulation. As blood is lost, either internally or externally, the body responds by attempting to improve the blood output of the heart — i.e., the heart pumps faster, causing the heart rate and therefore the pulse to speed up. As blood loss continues, the body responds by preserving the blood flow to the vital organs — e.g., brain, lungs, and heart — and diverting blood from non-critical areas — e.g., the skin and extremities. As blood loss continues, the radial pulse becomes weak and difficult to feel. The carotid and femoral pulses may continue to feel relatively stronger. This difference reflects the shifting of blood flow away from the extremities to the more important central organs.

As discussed in the primary survey, it is more important to assess the patient's pulses, particularly the radial and carotid pulses, than to measure blood pressure. In the secondary survey, the attendant should note the strength, rate, and regularity of the pulse. Use the pulse oximeter to calculate pulse rate and or use a watch with a second hand to count the number of beats in a 15-second interval, and then multiply that number by four to determine the number of beats per minute. The pulse rate taken manually should match the pulse oximeter rate. The pulse is usually easily felt and regular. Skipped beats or a weak or irregular pulse should be noted.

To detect irregularities of the pulse, it may be necessary to feel a pulse for a full 60 seconds. Irregularities of the pulse are most significant in the setting of a cardiac or respiratory emergency and less so with trauma patients. With trauma patients in the rapid transport category, remember the need for rapid medical intervention at a hospital. Do not lose precious minutes checking for irregularities of the pulse unless you are already en route to medical aid.

Level of consciousness

Assessment of the level of consciousness is especially important in the trauma patient who may have a head injury. In the past it has been difficult for the one attendant to describe to the next level of care changes in a patient's level of consciousness because descriptive terms such as drowsiness often mean different things to different people.

Currently, the use of descriptive terms has been discontinued and a scoring system called the Glasgow Coma Scale (GCS) has been adopted (see Table 3-3). The advantage of this scoring method is that its measurements are simple to use, reproducible, and objective.

Glasgow Coma Scale		
Eye-Opening Response	Spontaneous	4
	To voice	3
	To pain	2
	None	1
Verbal Response	Normal	5
	Confused but coherent	4
	Simple, inappropriate words	3
	Incomprehensible speech	2
	No speech	1
Motor Response	Obeys commands	6
	Localizes to pain	5
	Withdraws from pain	4
	Decorticate response (flexion)	3
	Decerebrate response (extension)	2
	No response	1
TOTAL	Highest possible score	15
	Lowest possible score	3

Table 3-3

Glasgow Coma Scale

The GCS measures the level of consciousness using three different functions of the nervous system:

- Eye-opening response
- Verbal response
- Motor response

The eye-opening response is measured by observing whether the patient opens their eyes in response to a stimulus.

- If the patient's eyes open spontaneously, score a 4.
- If the eyes open to verbal command, score a 3. Ask the patient to open their eyes; shout if necessary.
- If the patient's eyes open only in response to a painful stimulus, score a 2. To provide a painful stimulus, press on their fingernails with a hard object like a pen or pencil. Alternatively, squeeze the trapezius muscle, located between the neck and the shoulder, to provide a painful stimulus.
- If there is no eye-opening response, score a 1.

The verbal response or speech is the second category of the GCS.

- If the patient's speech is reasonably clear and
- coherent, score a 5.
- If the patient's speech is confused but at least understandable, score a 4.
- If the patient responds with simple, inappropriate words or only curses, score a 3.

- If the patient's speech is unintelligible or incomprehensible — e.g., moaning — score a 2.
- If the patient is unresponsive and cannot speak at all, score a 1.

The motor response is the final category of the GCS. The patient's motor responses or movements are assessed using verbal and/or painful stimuli. The attendant notes the best response. If the patient is paralyzed on one side, the motor response of the unaffected or better side would be used.

- The highest score in this category is 6 and indicates a limb is moved as instructed. The patient may still score a 6 in this category if a limb cannot be moved because of a nerve injury. For example, the fully responsive patient who verbally responds to questions or can stick out their tongue, or take a deep breath when asked, would score a 6.
- If the patient does not respond to a verbal stimulus but localizes (see below) to painful stimuli, score a 5.
- If there is withdrawal in response to painful stimuli, score a 4.

It may be difficult to distinguish between a score of 4 and 5. The following examples help illustrate the differences. If the patient is able to tell you to "stop squeezing my finger" (if that is the painful stimulus applied), the patient is localizing the pain because they can identify its source. Similarly, if the patient reaches over with the opposite hand and tries to push the attendant away or uses the opposite foot and leg to kick away at a painful stimulus on one foot, the patient is also localizing the pain. Simple withdrawal (when the patient does not appear to localize or identify the source of the pain) is a reflex action and scores a 4. The reflex that occurs when one touches something hot is an example of a simple withdrawal response.

As the level of consciousness decreases, the nervous system responds to painful stimuli with a primitive postural reflex. The first type of reflex is called the decorticate (flexion) response or decorticate posturing. It is usually manifested by simultaneous flexion of the upper extremities and extension of the lower extremities (see Figure 3-8a Decorticate posturing). The second type of reflex is called decerebrate (extensor) posturing and is manifested by extension and internal rotation of one or both upper extremities and extension of one or both lower extremities (see Figure 3-8b Decerebrate posturing).

- A decorticate response scores a 3.
- A decerebrate response scores a 2.
- No motor response at all to any stimulus scores a 1.

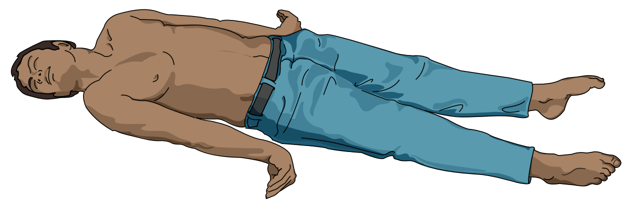

Figure 3-8a Decorticate posturing

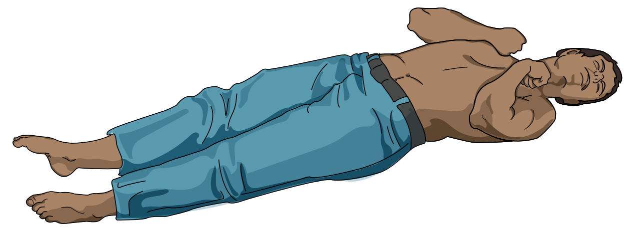

Figure 3-8b Decerebrate posturing

The GCS is summarized in Table 3-3. The lowest possible total score is 3 and the highest is 15. For example, a severely brain-injured patient:

- Does not open the eyes (eye-opening response is 1)
- Moans at times (verbal response is 2)
- Withdraws only to painful stimuli (motor response is 4)

The GCS, in this example, is therefore 1 + 2 + 4 = 7.

When reporting the score, the attendant always follows the same order:

1. Eye-opening score
2. Verbal-response score
3. Motor-response score
4. Total score

By telephone, the attendant will report the patient's level of consciousness as a 1 + 2 + 4 for a total of 7 on the GCS.

Patients with a GCS of 13 or less are in the rapid transport category. Similarly, if the patient's level of consciousness is decreasing, measured by a falling GCS, the patient must be upgraded to the rapid transport category.

Pupils

The attendant must examine the patient's pupils, especially if a head injury is suspected. The pupil is the dark, central disc in the middle of the eye. The pupils are normally round and are equal to each other in diameter. In light, their pupils each constrict (diameter gets smaller). In darkness, their pupils dilate (diameter gets larger). Shining a bright light — e.g., a flashlight — into one eye normally causes both pupils to constrict equally. Once the light is removed, the pupils both dilate back to their previous size (see Figure 3-9 Pupil reaction).

The attendant should examine both eyes and determine if the pupils are constricted, normal, or dilated, and whether they are equal to each other in size. The attendant should shine a light into one eye and note the pupillary response in both eyes Remember, the pupils should constrict quite briskly. If no light is available, the attendant can cover one of the patient's eyes with their hand and then quickly remove it. The pupillary response on uncovering each eye should be noted. Once again, the normal response is constriction.

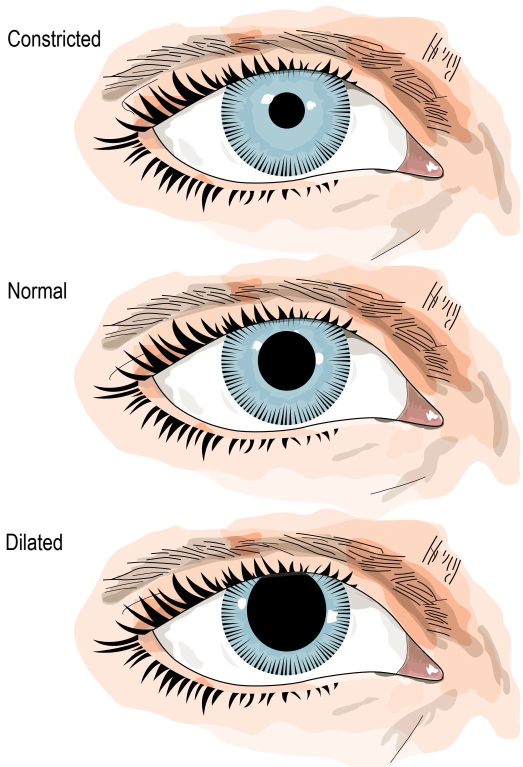

Figure 3-9 Pupil reaction

A dilated, poorly reactive pupil caused by head injury is usually associated with a significant decrease in the patient's level of consciousness. If one pupil is dilated and poorly responsive to light, the attendant must suspect a serious head injury and treat the patient accordingly. A significant percentage of healthy individuals have one pupil that is slightly larger than the other. The key difference between these individuals and those with serious head injury is that the slightly larger pupil of the normal individual constricts briskly to light, whereas the dilated pupil of the head-injury patient responds sluggishly or not at all to light. As noted above, head-injury patients with a dilated and poorly reactive pupil will have a decreased level of consciousness.

The attendant should not be fooled by patients with previous eye injuries or conditions — e.g., eye surgery, prescription eye drops, a prosthetic eye — that might result in an unusual pupillary appearance. This emphasizes the importance of obtaining the past medical history from either the patient or co-workers. Certain prescription drugs and some street drugs — e.g., cocaine, amphetamines, LSD — can dilate the pupils, but they affect both pupils equally.

Skin

Skin assessment requires checking for colour, temperature, and condition.

Colour — As previously discussed in relation to pulse, as blood is lost the body responds by preserving the blood flow to the vital organs — e.g., brain, lungs, and heart — and diverting blood from non-critical areas — e.g., the skin and extremities. This is why the patient becomes pale with blood loss. Blood vessels to the skin constrict, reducing the blood flow, causing the pale appearance. In the trauma patient, this may be an early indicator of impending hypovolemic shock (see page 98, Hypovolemic Shock).

A bluish discolouration of the skin is most likely due to cyanosis. Cyanosis is caused by low levels of oxygen in the blood. It is usually most noticeable in the lips, fingernails, or earlobes. The attendant should compare the colour of their own fingertips to those of the patient. The presence of cyanosis usually indicates a cardiorespiratory emergency. Once the airway is cleared or has been stabilized, a patient with cyanosis requires assisted ventilation. The presence of cyanosis is a criterion for assisted ventilation, which places the patient in the rapid transport category.

Temperature — As blood is lost, blood vessels supplying areas other than the vital organs constrict, reducing blood flow. One result is that the extremities (hands and feet) and the skin of the face can feel cool. This can be an early sign of shock (see page 98, Hypovolemic Shock).

The attendant should feel the patient's skin temperature on the forehead or abdominal wall with the back of their gloved hand (see Figure 3-10 Assessing body temperature). It is not necessary to remove your glove to do this assessment.

Changes in body temperature are important because the complex metabolism of body cells continues only within a narrow temperature range. Extreme changes in body temperature are life-threatening. Too low a temperature (hypothermia) and too high a temperature (heatstroke) are conditions that threaten life. Body temperature is not usually measured in the field.

Critically ill patients require rapid transport to hospital, so there is usually no time to measure temperature. If possible, prevent heat loss with insulation and/or warming devices, but do not allow patients to overheat. Patients with minor injuries do not require the measurement of temperature for treatment purposes.

Figure 3-10 Assessing body temperature

When hypothermia is a consideration — e.g., from exposure or near-drowning — the only reliable temperature measurement is a rectal recording. It is usually inconvenient, difficult, or embarrassing to measure a patient's rectal temperature. Furthermore, ordinary thermometers cannot be used to measure hypothermia because the scale on an ordinary thermometer does not go low enough, so special thermometers are required. For further discussion of this topic see page 274, Diagnosing Hypothermia.

Nevertheless, measuring temperature is important when evaluating someone for a possible wound infection or anyone with a medical illness (as opposed to a traumatic injury).

Condition — As blood loss continues, sweating usually occurs. In addition to being cool and pale, the skin may also feel moist or wet with perspiration. These findings are important early signs of hypovolemic shock (see page 98, Hypovolemic Shock).

With respect to skin condition, the attendant should record whether there is moisture due to something other than perspiration or blistering, such as what may occur with burns or a contact sensitizer.

The condition of the skin should be recorded in addition to the colour and estimate of temperature.

Reassessment of vital signs

Once the vital signs have been assessed and recorded, the attendant proceeds with the remainder of the secondary survey.

After the completion of the secondary survey, all patients must have their vital signs reassessed, recorded, and evaluated by the attendant at regular intervals to ensure that their condition is not deteriorating. Sets of vital signs recorded at regular intervals over time will give the attendant and medical personnel a picture of the patient's stable or changing condition. Frequent reassessment also ensures that any deterioration that would place the patient in the rapid transport category is discovered.

The vital signs are reassessed every

The vital signs are reassessed every:

- 10 minutes for RTC patients
- 30 minutes for non-RTC patients
- 10 minutes for the urban attendant with a patient requiring transport by BCEHS resources

History taking

The four components of history taking are:

1. Chief complaints and history of the current injury or illness
2. Allergies
3. Medications
4. Past medical history

Chief complaint(s) and history of current injury or illness

Obtain a history of the illness or injury — e.g., ask what happened. Determine the chief complaints by asking the responsive patient what is bothering them most. Ask the patient if they have experienced their chief complaint in the past and if so, how long ago. If the patient has some history with their chief complaint, ask whether they are under the care of a physician and what was done to help them in the past. Use this information to guide your investigation and transport decisions. In general, allow patients to answer in their own words. Try to avoid rapid-fire interrogation.

Sometimes the patient cannot remember or does not know what happened. In these instances, use other sources to determine what happened, or find out if there is some underlying diagnosed illness — e.g., diabetes or a seizure disorder. This information may be obtained from a medical alert bracelet, mobile device, co-worker, relative, or the family doctor's office. Sometimes, witnesses may be the only source of information. Obtaining the history of the injury is very important and this information must be recorded.

Patients with injuries usually complain of pain in the affected region. To help obtain all of the necessary information about a complaint of pain caused by injury or illness, remember the mnemonic PPQRRST. It stands for:

P = Position	Where is the pain located? Ask the patient to point to the most painful site.
P = Provoke	What makes the pain worse? Weight bearing? Movement? Breathing? Coughing?
Q = Quality	What does it feel like? Sharp? Throbbing? Burning? Aching? Pressure-like? etc.
R = Radiation	Does the pain move or radiate from one region to another? From the chest to the inner upper arm or jaw? From the lower back down the back of the leg?
R = Relief	Have you been able to relieve the pain in any way? Shallow breathing? Lying down/still? Vomiting?
S = Severity	On a scale of 1 to 10, with 1 being minimal pain and 10 being excruciating pain, how would you rate this pain?
T = Timing	How long ago did the pain start? Have you ever had pain like this before? Does it come and go or is it constant? Is it getting better, worse, or just staying the same?

Here is an example of how to use the PPQRRST mnemonic. The patient injured their back while lifting and twisting with a heavy object.

P = Position	Central low back pain
P = Provoke	Sitting, standing, or walking
Q = Quality	Severe stabbing low back pain with burning tingling right-leg pain
R = Radiation	Radiates from my lower back down my right buttock and back of the right thigh and calf into the outside of the right foot
R = Relief	Lying on my back with my legs bent
S = Severity	It is severe, at least 8 out of 10; it feels better if I don't move
T = Timing	It started as I lifted that heavy object half an hour ago and it is getting worse

The next important part of the history of current injury or illness is to determine if there are associated problems.

Associated problems may be directly related to the region of the injury or illness. The attendant should ask the patient whether there is any numbness, tingling, or weakness in the area of, or distal to, the injury.

Associated problems may also involve systems other than the one which is of primary concern. The attendant should ask the patient:

- Can you breathe easily?
- Is there any pain, numbness, tingling, or weakness in any other parts of your body?
- Do you feel dizzy, have blurred vision, or feel nauseous?
- Do you feel the need to urinate or have a bowel movement??

Allergies

Information concerning allergies is also very important. With an unresponsive patient, look for medical alert devices, etc. The following information about allergies is very important to medical staff:

- Whether the patient has ever had an allergic or adverse reaction to:
  - Any drug or medication — e.g., penicillin
  - Chemicals — e.g., perfume, topical agents
  - Foods — e.g., nuts, chocolate
  - Pollens, animal fur, dust
- Information about the nature of any such reaction
- Whether the patient needed medical or hospital attention or admission to an Intensive Care Unit
- Whether the patient is taking any medication for allergies at present

Medications

It is important to document the patient's current medications if at all possible. This information is very helpful to medical staff and occasionally may be lifesaving. It should include prescriptions and over-the-counter medications. The following details about current medications are important:

- Name of drug
- Dose — usually in mg per tablet or teaspoon
- Frequency — how often each day the patient uses the medication
- Purpose — what the medication is used for
- Compliance — whether the patient is taking the medication as directed
- Expiry date of the medication

Past medical history

The last step in the history taking process is to ask about other medical conditions — e.g., diabetes, heart disease, respiratory illness, seizures — and to ask about past illnesses related to the major complaint.Using the same example of the patient with the back injury, it would be helpful to find out if the patient has had similar problems in the past, such as a disc herniation in the lower back. The attendant should also inquire about previous relevant hospitalizations or surgery.

Head-to-toe examination

The general approach to the head-to-toe physical examination is inspection and palpation — i.e., look and feel — starting with the head and proceeding down through the various regions: neck, chest, abdomen, pelvis, back, and extremities. The head-to-toe examination is similar to the rapid body survey. Unlike the rapid body survey, the head-to-toe examination should be methodical and focused and usually takes several minutes to complete. The attendant is looking and feeling for injuries and/or painful areas that are not obvious. The attendant must again watch out for sharp objects — e.g., tools, debris, needles — in the patient's clothing or pockets.

The head-to-toe examination includes systematic assessment of the following regions and is performed in the following order:

1. Head
2. Neck
3. Chest, abdomen, and pelvis
4. Back
5. Extremities

The final two steps of the head-to-toe examination are:

6. Neurological examination
7. Assessment for spinal injury

Head

The attendant checks the patient's head and face for open wounds, lacerations, swelling, and deformities. The nose and oral cavity should be inspected for lacerations, blood, and broken/displaced teeth. The patient's eyes also require careful assessment. If the patient is awake and alert enough, inquire about quality of vision; ask about contact lenses. The pupils were examined as part of assessing the patient's vital signs but may be reassessed at this time.

Open wounds and deep lacerations should not be probed, as this may cause excessive bleeding or further injury to delicate structures, such as nerves or blood vessels. The facial bones and scalp should be palpated for areas of deformity or tenderness. Patients with facial fractures are at particular risk for developing airway obstruction from soft-tissue swelling or bleeding.

The attendant should examine the ear canals for hearing aids, evidence of bleeding, or leakage of clear fluid (cerebrospinal fluid). The areas just behind the ear and around the eyes should also be examined for bruising. Both clear fluid and bruising are possible signs of fracture of the base of the skull (see page 126, Skull Fractures).

Neck

The attendant also inspects the neck for evidence of injury, looking for swelling, deformity, and open wounds. Patients with injuries to the anterior aspect of the neck may develop airway obstruction. Listen for evidence of hoarseness or stridor (high-pitched noise on inspiration and/or expiration). Because major arteries and veins are in the neck, penetrating neck injuries are potentially life-threatening.

Again, open wounds should not be probed. Bleeding must be controlled by direct pressure. Direct pressure applied to wounds of the neck usually will not cause airway obstruction. The attendant must take care not to apply pressure simultaneously to both sides of the anterior neck. Swelling of the neck from blunt or penetrating injury is also particularly dangerous because it may extend internally and cause airway obstruction.

All multi-system trauma patients with a decreased level of consciousness must be assumed to have a cervical spine injury and be properly packaged on a well-padded structure. The conscious patient should be asked whether they have neck pain. If the answer is positive, the cervical spine may need to be secured using a cervical collar. See Figure 3-11 Modified Nexus rule. See also appendices D and E for additional explanations of spinal motion restriction.

Modified NEXUS rule

For alert (GCS=15) and stable trauma patients where cervical spine injury is a concern

1 "We take manual stabilization based on Mechanism of Injury"

Apply manual C-spine stabilization as indicated by MOI

Complete the primary survey

2 "We maintain Spinal Motion Restrictions based on physical findings"

Apply the Modified NEXUS Rule

Is the patient reliable?

1. Is the patient fully alert?
2. Is the patient showing any signs of intoxication?
3. Does the patient have any distracting injuries?

Are there any concerning physical findings?

4. Midline cervical discomfort?
5. New onset focal neurological deficits?

Are there any other concerning considerations?

6. Is the patient over the age of 65?
7. Does the patient have any pre-existing spinal conditions?
8. Is this a multi-sytem trauma?

If the answer is no to ALL of the above SMR is not required

If you are in doubt, err on the side of caution and apply SMR

3 "If in doubt apply SMR"

Notes for applying the Modified NEXUS Rule

1. Fully alert is defined as alert on AVPU, alert & oriented to person/place/time/events, answering questions appropriately, GCS=15
2. Signs of intoxication may include, but are not limited to: Unable to comprehend, uncooperative, slurred speech, ataxia, recent history of drinking
3. A distracting injury is one that results in pain sufficient to distract the patient from a secondary (neck) injury. i.e. A femur fracture, profound hemmorhage, a large burn
4. Midline cervical discomfort is pain, tenderness or discomfort along the spinal column from the nuchal ridge to the first thoracic vertebrae
5. New onset focal neurological deficits include any new numbess, tingling, or paralysis in the extremities
6. Patients over the age of 65 are at greater risk of spinal injuries and should have SMR applied where appropriate
7. Pre-existing spinal conditions may include, but are not limited to: Osteoporosis, Ankylosing Spondylitis, etc.
8. Multi system trauma refers to more than one simultaneous injury, such as multiple bone fractures, major lacerations and damage to internal organs or major blood vessels

Figure 3-11 Modified NEXUS Rule

Chest, abdomen, and pelvis

The chest and abdomen are then examined for evidence of injury. The attendant must look for bruising and open wounds and palpate the chest and abdomen for tenderness. Chest wall or abdominal wall injuries must alert the attendant to the possible presence of serious internal injuries. The motion of the chest wall both anteriorly and laterally should be observed during deep inspiration and expiration for evidence of pain, flail chest, or pneumothorax. Ideally, the attendant should observe the movements of the posterior chest (middle and upper back); however, injuries to the neck or spine may preclude direct observation, and in this case, the attendant must at least palpate the posterior chest regions during full inspiration and expiration to assess for injury.

Normally, when a person breathes in the chest wall rises, and when they breathe out, it falls.
With multiple rib fractures, a segment of the chest wall may become disconnected from the rest of the bony thorax. On inspiration, this segment will not rise but will paradoxically fall inward. On expiration, as the chest wall

falls in, this segment will expand outward. The condition is known as flail chest and is usually associated with severe pulmonary injury and dysfunction.

The attendant should note whether the abdomen is tender to palpation or is distended. It is important to assess not only the anterior abdominal wall but also both sides for visible signs of injury as well as tenderness. These signs may indicate internal bleeding.

The bony pelvis should be palpated by placing the hands on the iliac crests and first gently pushing down and then compressing inward to look for evidence of instability or tenderness.

Back

The back examination is often overlooked in the rush to get the trauma patient to medical aid.

For the RTC multi-system trauma, head and/or spinal-injured patient, the back should be examined during the move to the stretcher. The helper can quickly look at or feel the back while the patient is moved onto the stretcher. If any deformity or wound is found, the attendant must fully expose and examine the back.

An initial examination of the non-RTC supine patient can be performed by the attendant gently working their hands under the patient and palpating the entire back for obvious bleeding, tenderness, and deformity. If evidence of an open wound is found, the patient must be log-rolled at the end of the secondary survey for specific examination and dressing.

The extremities

The extremities are examined for evidence of trauma. Both upper and lower extremities must be checked for lacerations, swelling, and gross deformity. Fractures usually cause pain, swelling, and deformity of an affected limb. The attendant should therefore palpate each limb for signs of deformity or pain. For a patient with a decreased level of consciousness, the attendant may have to rely on evidence of swelling and/or deformity. When a fracture or deep laceration is present, it is crucial that the attendant examine the pulses distal to the injury site to determine whether a vascular injury is present. For injuries of the upper extremities, the radial pulse on the affected side must be checked. For injuries of the lower extremities, the attendant must check the dorsalis pedis pulse (on top of the foot; see Figure 3-12a) or the posterior tibialis pulse (on the inside of the foot behind the ankle; see Figure 3-12b).

Figure 3-12a Assessing the dorsalis pedis pulse

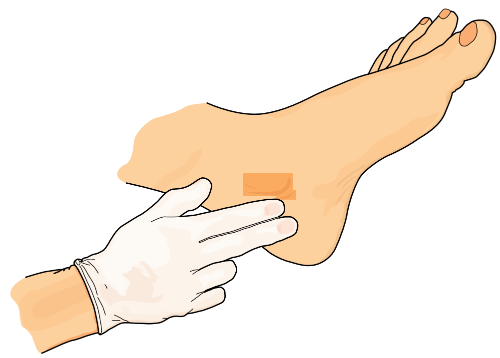

Figure 3-12b Assessing the posterior tibalis pulse

Checking the appropriate distal pulse is still the most reliable method of assessing circulation to the extremities. However, checking for capillary refill in the fingers or toes of the affected limb also gives an indirect indication of circulation. Capillary refill is the rapid return of colour (in less than 2 seconds) to nail beds or skin after squeezing the tip of a finger or toe. Assessing skin temperature of the corresponding hand or foot may also be helpful. Unfortunately, in a cold environment capillary refill and skin temperature tests are unreliable.

Neurological examination

A neurological examination must be performed, especially if a head or spinal-cord injury is suspected or if the patient has a fracture or deep laceration to a limb.

The neurological examination has three components:

- Assessment of the level of consciousness using the Glasgow Coma Scale (GCS)
- Examination of pupils and their response to bright light
- Determination of sensory and motor function of the face and all limbs

The patient's level of consciousness and pupillary response have already been assessed during the taking of the vital signs. Now the attendant must assess both sensory and motor function.

Sensory function may be tested by asking the conscious patient if there is numbness or tingling anywhere. The patient should also be asked what they feel when the attendant lightly touches the fingers, toes, or other part of the patient's body. In the patient with a marked decrease in consciousness, sensory function is impossible to assess accurately.

However, if the patient responds to a painful stimulus, this shows that at least some sensory function is present. The absence of any response indicates that either sensory or motor function is absent but nothing more specific.

Motor function is assessed by testing the various muscle groups of the body. To preserve precious minutes, the attendant should focus on motor function of the face, the upper extremities, and the lower extremities.

Motor function of the face can be assessed by having the patient smile or by noting the facial features' response to a painful stimulus. A facial droop is a sign of paralysis of the facial muscles. The patient is unable to lift one corner of the mouth when smiling or grimacing (i.e., it droops).

Motor function of the upper extremities is tested either by examining hand grips (by asking the patient to squeeze the attendant's fingers with each hand) or by having the patient raise both arms upward and perpendicular to the body. The best method is left to the judgment of the attendant, taking into consideration any upper-extremity injury (see Figure 3-13 Assessing motor and sensory function in the upper limbs).

The motor function of the lower extremities is examined in a similar way (see Figure 3-14 Assessing motor and sensory function in the lower limbs), providing local injury does not prevent the examination. The attendant should ask the patient to dorsiflex the ankle against resistance, to plantar flex the ankle against resistance, and to wiggle the toes. In addition, the patient should be asked to lift one leg at a time, 30 cm (1 ft.) off the ground.

The attendant should specifically look for the presence of weakness and for any asymmetry between the strength of the right limb compared to the left.

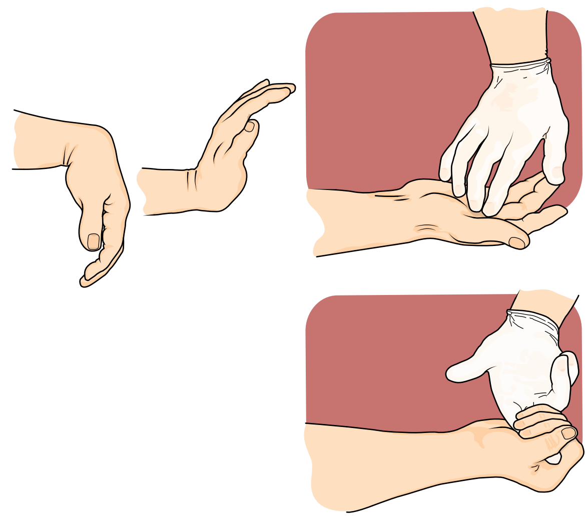

Figure 3-13 Assessing motor and sensory function in the upper limbs

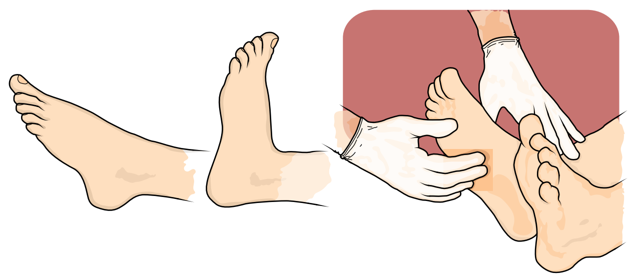

Figure 3-14 Assessing motor and sensory function in the lower limbs

In the patient with a decreased level of consciousness, the attendant should observe the response to a painful stimulus applied to each extremity (e.g., pressure on the nail bed). The absence of a response may indicate paralysis of that limb.

Similarly, the response of one limb should be compared with the response in the other. Asymmetry of response or lack of any response, in the absence of a significant injury to the limb, usually indicates neurological injury.

Once the neurological examination is completed, it is imperative that the attendant record any findings as well as the time of the examination. Any further neurological examinations should be similarly documented, including the time. This will provide a sequential picture of the patient's neurological status and whether there is deterioration or improvement These examinations and the recordings are essential information for medical staff and may help determine the need for urgent neurosurgical intervention.

Assessment for spinal injury

If the attendant could not rule out the need for spinal motion restriction earlier and no evidence of a spinal injury has been discovered by the end of the head-to-toe examination, the attendant should apply the modified NEXUS rule, to determine if ongoing cervical spine motion restriction is needed (see Figure 3-11 Modified NEXUS rule):

1. Fully alert, GCS=15
2. No signs of intoxication
3. No distracting injuries
4. No midline cervical pain, tenderness or discomfort along the spinal column from the nuchal ridge to the first thoracic vertebrae
5. No new onset focal neurological deficits
6. Patients is under the age of 65
7. No pre-existing spinal conditions
8. Not a multi-system trauma patient

If the need for cervical spine immobilization has been ruled out, the attendant helps the non-RTC patient to roll onto their side to assess and palpate whether they have any thoracic or lumbar spine pain. If any pain or stiffness is found along the spine, the patient must be managed as if they have a spinal injury. Only if the patient reports no pain or stiffness can the attendant safely rule out the need for spinal motion restriction.

Head-to-toe reassessment

The attendant must carefully reassess and re-examine known sites of injury. Check dressings and bandages for evidence of ongoing bleeding or impaired circulation. Splints that were applied ealier must be reassessed to ensure that there has been no significant change in position. The neurological and circulatory status of injured limbs must be monitored. Patients with head, chest, or abdominal injuries must also be closely re-examined to detect any changes. As part of patient monitoring, the attendant performs a limited physical examination, not only focusing on the injured areas but also looking for evidence of new injuries.

This re-examination must be repeated every 30 minutes during transport. Patients in the rapid transport category may require more frequent reassessments, depending on the status of their vital signs. In general, the sicker the patient, the more frequent the reassessments.

Summary

This completes the secondary survey; a complete assessment of the patient is as follows:

- Vital signs
- History taking:
  - Chief complaints and history of current injury or illness
  - Allergies
  - Medications
  - Past medical history
- Head-to-toe examination:
  - Head
  - Neck
  - Chest, abdomen, and pelvis
  - Back
  - Extremities
  - Neurological examination
  - Assessment for spinal injury

Having completed the secondary survey, the attendant can proceed in a logical and systematic way to prioritize the patient's injuries and treat them accordingly. The beginning of this section emphasizes the importance of identifying seriously injured patients and rapidly transporting them to hospital. Understanding basic anatomy and remembering the concept of energy transfer and injury potential, the attendant should be alerted to the possibility of major trauma whenever certain injuries are present. Because of the reserve capacity of the circulatory and respiratory systems, the patient's vital signs may initially be normal in spite of a serious injury. The attendant is reminded of the importance of the rapid transport criteria outlined on page 30.

Patients require close monitoring, which includes:

- Reassessment of the ABCs:
  - Every 5 minutes for RTC patients
  - Every 10 minutes for non-RTC patients
  - Every 5 minutes for the urban attendant with a patient requiring transport by BCEHS resources
- Assessment and recording of the vital signs:
  - Every 10 minutes for RTC patients
  - Every 30 minutes for non-RTC patients
  - Every 10 minutes for the urban attendant with a patient requiring transport by BCEHS resources
- Reassessment of the head-to-toe examination every 30 minutes, particularly the head and neurological examination if there has been a head injury, and examination of the chest and abdomen, as well as of any significant injury site

Priority action approach summary

This chapter has covered all the essentials of trauma assessment according to the priority action approach. Following the methods outlined in this section allows the attendant to focus on the patient rather than trying to figure out what to do next. However, practice makes perfect, and optimal speed and efficiency are achieved by teamwork. The attendant should plan regular exercises in patient evaluation to maintain skills. Above all, remember the trauma patient urgently requires medical intervention at a hospital.

Here is an outline of the priority action approach for injured workers:

1. Scene assessment
2. Primary survey:
   - Critical interventions
   - Airway with C-spine control as appropriate
   - Breathing
   - Circulation
3. Transport decision
4. Secondary survey

Part 4

Respiratory System

Anatomy and function of the airway and respiratory system

All living cells of the body extract energy from nutrients in a process called metabolism. In the course of metabolism, each cell preferentially uses oxygen and produces carbon dioxide as a waste substance.

Each living cell in the body requires a constant supply of oxygen, although some cells are more dependent than others. At normal temperatures, cells in the brain and central nervous system begin to die after four to six minutes without oxygen. Those cells can never be replaced and permanent disability may result from the damage.

Respiratory System

The respiratory system supplies oxygen to the blood and removes the gaseous waste product carbon dioxide from it. Oxygen is obtained from the air, which is a mixture of oxygen, nitrogen, carbon dioxide, and other gases. Air is delivered to the body through the respiratory system (see Figure 4-1), which consists of:

- Airway (nose, mouth, pharynx, trachea, bronchi)
- Lungs (bronchioles, alveoli, pleura)
- Thoracic muscles (intercostal muscles, diaphragm)
- Thoracic bones (ribs, sternum)

The purpose of the respiratory system is to maintain appropriate levels of oxygen and carbon dioxide in the body.

The various tissues of the body, such as muscle, brain, and heart, require oxygen and other basic nutrients to perform their functions. For tissues to function normally, the body must maintain a certain level of oxygen (O_2). However, prolonged exposure to high levels of oxygen may be harmful. Carbon dioxide (CO_2) is one of the waste products of tissue function, sternum. The body cannot function with high levels of acid.

Anatomy

The components of the respiratory system are:

- Airway
- Lungs
- Thorax

The airway is composed of the nose, mouth, and throat (pharynx). The lower part of the pharynx divides into two passageways: the esophagus (through which food passes on its way to the stomach) and the trachea (which opens into the lungs). The trachea lies in front of (anterior to) the esophagus. The trachea is reinforced by hard cartilage rings. The trachea can be palpated in the midline, extending from the Adam's apple to the tracheal opening is protected by a small flap of tissue called the epiglottis. The muscles of the pharynx will cause the epiglottis to close the tracheal opening when swallowing. Below the epiglottis is the larynx, or voice box (see Figure 4-1 Respiratory system). This part of the trachea contains the vocal cords. Complete airway obstruction results in not only an inability to breathe but an inability to produce sounds. The airway acts only as a passageway, carrying air rich in oxygen into the lungs with inhalation and carbon dioxide away from the lungs with exhalation.

Airway

Nose and mouth

The upper airway is made up of the nose and mouth. Air is taken in through the nose and/or mouth. The lining of the nasal cavities contains many blood vessels, which heat and moisten the air before it enters the lungs.

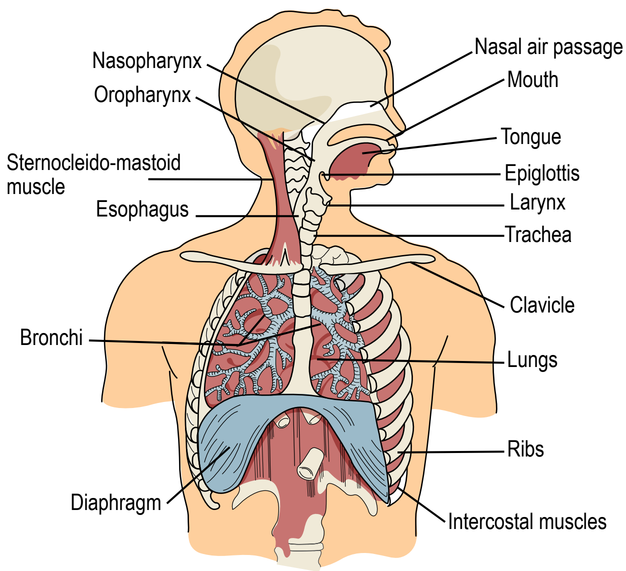

Figure 4-1 Respiratory system

Pharynx

Air from the nose and mouth passes into the back of the throat (pharynx). The pharynx is muscular and serves as a passageway for foods and liquids into the digestive system and for air into the respiratory system. The lower portion of the pharynx opens into two passageways:

- Anteriorly (in front), the air pathway through the larynx (voice box) down the trachea and into the lungs
- Posteriorly (in back), the food pathway into the esophagus

Guarding the opening of the larynx is a small oval flap of tissue called the epiglottis. The epiglottis keeps food and foreign material out of the trachea, thus preventing choking (see page 49, Anatomy). The epiglottis is considered the dividing line between the upper airway and the lower airway.

Trachea

The trachea is a tube that extends from the lower edge of the larynx to the centre of the chest behind the heart. It carries air from the larynx to the bronchi. It is a semi-rigid tube partially supported by rings of cartilage.

These rings keep the trachea from collapsing when air is moved in and out of the lungs.

Bronchi

The trachea divides into the left bronchus and the right bronchus. These are the two main air tubes that carry the air from the trachea into the lungs.

Lungs

There are two lungs, one on each side, suspended in the thoracic cavity. The lungs have a rich supply of blood vessels. Carbon dioxide produced in the body tissues is carried to the lungs by the blood, where it is exhaled. Oxygen, absorbed into the blood in the lungs, is transported to the body tissues.

Bronchioles

As soon as each bronchus enters the lung, it subdivides into branches resembling those of a tree. Each individual bronchial tube subdivides again and again, forming progressively smaller tubes. The smallest are called bronchioles.

Alveoli

At the end of each bronchiole is a cluster of air sacs that resembles a bunch of grapes. These sacs are known as alveoli. Each alveolus has a very thin wall, covered with many tiny capillaries. This arrangement provides an easy passage for oxygen and carbon dioxide entering and leaving the blood, respectively.

As blood passes through the capillaries of the alveoli, gas exchange takes place. Oxygen leaves the air in the alveolus and passes into the blood in the capillary, while carbon dioxide passes in the opposite direction.

Pleura

Covering each lung is a double-walled sac of very smooth, slippery tissue called pleura. One layer of this sac lines the inside of the chest cavity and the other layer covers the lungs. Between these two layers is the pleural space, which is, in fact, only a potential space, because the layers are in contact everywhere. Each layer is tightly sealed against the other by a thin film of fluid. When the chest wall expands, the lung is pulled with it and expands because of suction exerted by these closely applied pleural surfaces.

Any break in the sealed pleura will permit air or blood to enter and separate the pleural surfaces, creating a space between the lung and the chest wall. A collection of blood in the pleural space from trauma to the lung or chest wall is called a hemothorax. The presence of air in the pleural space is called a pneumothorax. A collection of fluid is called a pleural effusion. Any collection of fluid, blood, or air in this pleural space will interfere with efficient respiration.

Thoracic muscles and bones

The thoracic (chest) cavity is a bony cage made up of 12 thoracic vertebrae, 12 pairs of ribs, and the sternum (breast bone). It is bound below by a thin, strong layer of muscle called the diaphragm. The diaphragm separates the thoracic cavity from the abdominal cavity. Between the ribs are layers of intercostal muscles. The diaphragm and the intercostal muscles are the major muscles involved in breathing. The thorax contains the lungs, esophagus, trachea, heart, and major blood vessels (see Figure 4-2 Organs of the chest cavity).

On the outside of the chest wall are voluntary muscles over the chest, shoulders, and neck. These muscles are used primarily for voluntary movement. In extreme respiratory distress, these muscles are also used to assist breathing. They are called the accessory muscles of breathing. The thoracic space between the lungs is called the mediastinum. It contains the heart, major blood vessels, trachea, and esophagus.

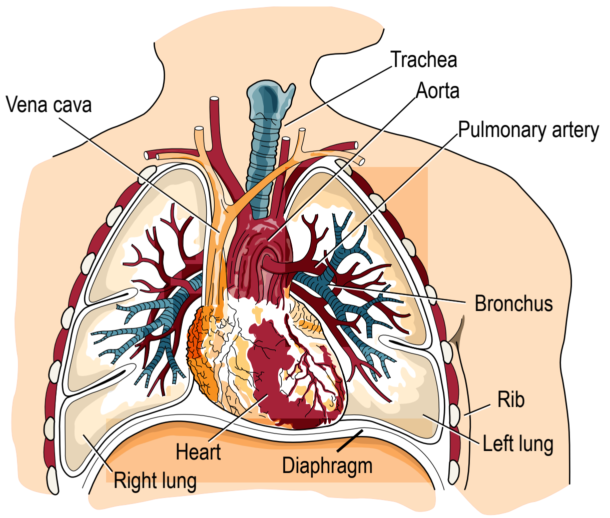

Figure 4-2 Organs of the chest cavity

Mechanics of breathing

There are two phases of breathing:

1. inhalation — air drawn into the lungs
2. exhalation — the expulsion of air from the lungs

During inhalation, the muscles of respiration (the diaphragm and intercostal muscles) contract, pulling down the diaphragm and lifting the ribs, thus enlarging the thoracic cavity. When the thoracic cavity enlarges, pressure decreases, causing a negative pressure within the chest. This causes an expansion of the elastic lung tissue so that air rushes in to fill the air sacs.

During exhalation, the muscles of respiration relax, decreasing the size of the thoracic cavity. As the pressure in the chest increases, air is pushed out through the trachea (see Figure 4-3 Mechanics of breathing).

Three processes are essential for the transfer of oxygen from the outside air to the blood flowing through the lungs: ventilation, diffusion, and perfusion.

1. Ventilation is the process by which air moves in and out of the lungs.
2. Diffusion is the spontaneous movement of gases, without the use of any energy or effort by the body, between the gas in the alveoli and the blood in the capillaries in the lungs.
3. Perfusion is the process by which the cardiovascular system pumps blood throughout the lungs.

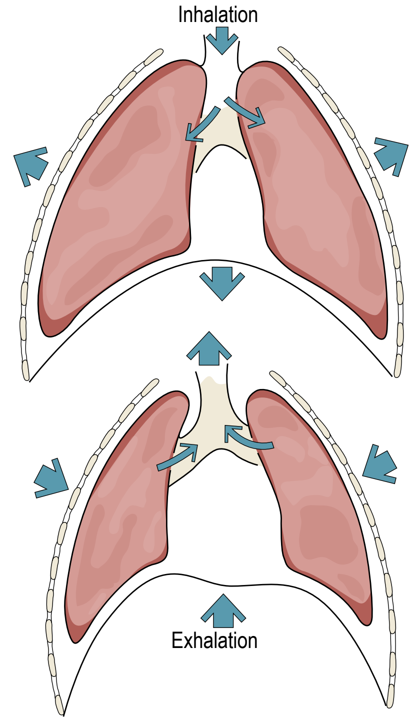

Figure 4-3 Mechanics of breathing

Respiratory centre

Breathing is controlled by the respiratory centre in the brain stem (at the base of the brain). Breathing is involuntary, but it can be controlled to some extent.

The respiratory centre is governed by changes in the chemistry of the blood. If there is an increase in carbon dioxide or a decrease in oxygen (i.e., hypoxia) the respiratory centre is stimulated to increase the respiratory rate. The increase in respiratory rate will increase the level of oxygen and decrease the level of carbon dioxide in the blood.

Respiratory rate

The normal rate of breathing for an adult at rest varies from 12 to 20 times per minute; it is normally higher in children. The oxygen demand of the body depends upon the degree of activity in body cells. When there is more demand for oxygen, this usually results in an increased respiratory rate. Some injuries and diseases affect the respiratory rate.

Airway management

The objective of airway management is to establish and maintain an open passage for air to enter and leave the lungs. There is little doubt that, of all the possible procedures the attendant may perform, securing and maintaining a "patent" (clear) airway in the ill or injured patient is truly lifesaving and always the first priority. The attendant has limited techniques and equipment at their disposal. Therefore, the attendant must become expert at recognizing and treating the unstable airway. The inability to recognize, or failure to treat, an unstable airway may be fatal.

Airway assessment

Airway assessment is the first priority for any patient. Whether the patient is responsive or not determines the next sequence of events.

If the patient is unresponsive and not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest. In this situation CPR/AED is initiated according to Part 5, Chapter 13.

It is known that early in cardiac arrest, (circulatory arrest) patients may have gasping 'agonal' respirations. The presence of these ineffective gasping agonal respirations in the unresponsive patient should alert the attendant that cardiac arrest has occurred. If the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest and CPR should be initiated without delay. Although there is a slight risk of chest injury from initiating CPR when unresponsive patients are not in cardiac arrest, the risk of delaying CPR for cardiac arrest is greater. Therefore, the attendant must not delay chest compressions. The attendant must assume that if the unresponsive patient is not breathing normally, they are either in cardiac arrest or suffering an airway obstruction. In either instance, chest compressions are appropriate.

In all other patients, the treatment of airway emergencies must be guided by two concerns:

- Is the patient conscious?
- Is a cervical spine injury suspected?

Cervical spine injury should always be suspected if the mechanism of injury suggests spinal trauma.

In cases where the patient is not in cardiac arrest, the attendant should use the "look, listen, and feel" approach to airway assessment. Conscious patients will usually be able to indicate, either verbally or by gesturing, that an airway problem exists. The attendant should identify themself in a reassuring manner, tell the patient to remain calm and ask a simple question like "What happened?" The patient's reply will give immediate information about the patency of the airway and level of consciousness. If the patient responds with clear speech, it is now established that the airway is clear.

If the patient is unable to respond verbally, or does so with a hoarse voice or stridor, the attendant may have to take further action to ensure an open airway.

Stridor is a high-pitched noise that may be present on inspiration or expiration, or both. It results from a narrowing of the airway, which creates a whistling noise with the passage of air. Stridor thus signals the presence of a partially obstructed airway that may become completely closed (occluded).

Airway obstruction results in an inability to maintain normal, spontaneous, or assisted ventilation. An unstable airway is either partially or completely obstructed. The passage of air in and out of the airway (i.e., breathing) is normally quiet. Noisy, congested, or gurgling breathing may be signs of a partially obstructed airway. Hoarseness may indicate injury to the vocal cords, located in the larynx. This is also a sign of an unstable airway.

The attendant first looks at the patient and checks for the presence of cyanosis and/or evidence of respiratory distress. The attendant can visually check for respiratory movements of the chest. The patient may be able to open their mouth and the attendant should perform a visual check for foreign bodies, bleeding, swelling, or burns. Listening for air moving in and out of the mouth or nose is best doneby placing an ear next to the patient's face. Finally, the attendant may feel for the movement of air with the cheek or bare hand. The rise and fall of the chest wall may also be assessed by feel.

Conscious patients with partial or complete airway obstruction usually maintain a position that maximizes their ability to breathe and minimizes the degree of airway obstruction. The conscious patient with a complete airway obstruction will usually give the universal distress signal for choking by clutching their neck between the thumb and index finger. These patients may be quite agitated and resistant to attempts to provide any treatment. For example, a face mask for providing supplemental oxygen may feel suffocating to the patient.

The patient with a completely obstructed airway will soon be cyanotic or ashen grey. With each attempt at respiration, the muscles of the neck and chest wall (accessory muscles of breathing) will be taut in an attempt to draw air into the lungs. You may see the trachea being tugged down from above the sternum into the chest. If the obstruction has been present for some time, the patient may lose consciousness and cease making respiratory efforts. When an attempt is made to ventilate the patient, the chest wall will not rise because air cannot enter the lungs. As soon as the presence of a partially or completely obstructed airway is recognized, the attendant must immediately begin the basic procedures to clear the airway.

Signs of compromised airway

Partial Obstruction	Complete obstruction
• Noisy, congested, or gurgly breathing • Hoarseness • Stridor • Possible cyanosis	• Cyanosis • No movement of air in or out of the mouth • Chest wall does not rise with ventilation • If conscious, unable to vocalize

Table 5-1

Causes of airway obstruction

The most common cause of airway obstruction in the unresponsive patient is blockage by the tongue. In the unresponsive supine patient who has lost voluntary control of the muscles of the mouth and throat, the tongue falls backwards and obstructs the airway. Lifting the jaw by the recommended manoeuvres will cause the tongue to be pulled up and out of the way. Insertion of an oropharyngeal, or oral, airway will help to maintain a clear airway.

Foreign bodies are the next most common cause of airway obstruction. During the airway assessment, foreign bodies such as loose-fitting dentures or broken teeth must be removed. Vomitus and blood can also obstruct the airway and must be removed using patient positioning, finger sweeps, and/or suction.

Swelling from injury to the soft tissue of the throat, neck, or larynx can also cause airway obstruction. Some of the more common causes of such tissue injury are direct blows to the anterior neck, facial fractures, and smoke or chemical inhalation.

Often the onset of airway obstruction is delayed. The attendant must reassess patients for signs of airway compromise. Many patients are fine initially but deteriorate rapidly from delayed onset of airway obstruction.

Airway management: Techniques for opening and clearing the airway

Cough

When the airway is partially obstructed and the patient is conscious, with good air entry, coughing forcefully is the most effective way to clear the airway. A strong cough can generate enough force to dislodge and expel most foreign bodies.

Finger sweep

If possible, the attendant should attempt a visual check of the oral cavity before performing a finger sweep. The mouth can be opened with a tongue/jaw lift. The jaw and tongue are grasped with one hand, allowing a finger sweep with the other hand (see Figure 5-1 Tongue/jaw lift finger sweep).

Figure 5-1 Tongue/jaw lift finger sweep

Loose-fitting or broken dentures and foreign bodies can be removed in this way. For the patient with no possibility of cervical spine injury, foreign material can be removed from the airway by turning the patient's head to one side and sweeping the back of the throat with the index finger. The foreign body can be dislodged and hooked into the mouth where it can be removed. If there is a possibility of a spinal injury, and there is difficulty removing a foreign body, the whole patient can be turned as a unit, with the head, neck, and trunk stabilized, and the finger sweep performed in the lateral position. For patients with vomitus and/or secretions in the airway, the finger sweep should be done in the lateral position.

Head-Tilt Chin-Lift

For the unresponsive patient with no possibility of cervical spine injury, the head-tilt chin-lift technique can easily open the airway (see Figure 5-2 Head-tilt chin-lift). With the patient in the supine position, the neck is extended by pushing the patient's forehead back with one hand while the chin is lifted vertically. This should not cause any pain. Never extend or tilt the head to open the airway on a trauma patient with suspected cervical spine injury unless all other airway manoeuvres fail. The unresponsive trauma patient with suspected cervical spine injury must be treated differently. Tilting or extending the head of a patient with a cervical spine fracture may result in permanent spinal-cord injury (paralysis) or death.

Figure 5-2 Head-tilt chin-lift

Jaw thrust

A jaw thrust is the best procedure to open the airway for the unresponsive trauma patient with suspected cervical spine injury. This method requires only one rescuer. The attendant is positioned at the head of the patient with the elbows firmly anchored, preferably on a stable surface at each side of the patient's head. The attendant's hands are placed on each side of the head with two or three fingers positioned behind the angle of the jaw and the thumbs on the cheekbones. Lifting with the fingers, the attendant pulls the jaw upward as the cheekbones are held down with the thumbs (see Figure 5-3 Jaw thrust). This should not cause any pain. The neck should not be extended or tilted as the jaw is pulled up.

Figure 5-3 Jaw thrust

Back blows

Back blows are used only on a conscious (sitting or standing) patient with a suspected foreign-body obstruction of the upper airway. They are not effective for partial or complete airway obstruction due to swelling, secretions, or bleeding (e.g., smoke inhalation) or blunt neck or facial trauma. From the side of the patient, the attendant supports the patient with an arm across the upper body and has the patient lean forward. The attendant delivers up to five sharp blows between the patient's shoulder blades with the heel of the hand.

Abdominal thrusts

Abdominal thrusts are used only on a conscious (sitting or standing) patient with a suspected foreign-body obstruction of the upper airway. It is not effective for partial or complete airway obstruction due to swelling, secretions, or bleeding (e.g., smoke inhalation or blunt neck or facial trauma).

- From behind the patient, the attendant wraps
- both arms around the patient's waist.
- The attendant then makes a fist with one hand and holds the fist with its thumb side against the patient's abdomen midway between the top of the hip bones (iliac crests) and above the navel.

- The attendant then grasps the fist with the other
- hand and presses it into the patient's abdomen with a quick, forceful thrust directed upward.

Chest thrusts

- If the patient is standing or sitting and is in late stages of pregnancy or is too obese for the attendant to get their arms around the abdomen, then they should do back blows followed by chest thrusts
- To deliver chest thrusts the attendant places both
- of their arms under the patient's armpits and wraps their arms around the patient's chest. The attendant then makes a fist with one hand and holds it against the centre of the patient's sternum breast bone).
- The attendant then grasps their fist with the other hand and pulls sharply against the patient's chest with a quick, forceful pull directed inward towards the patient's spine.
- Chest thrusts must be delivered sharply to compress the lungs and use the force of the trapped air to forcefully remove the object. Continue thrusts until the object is relieved or the patient becomes unconscious.

Chest compressions

Chest compressions are used on all supine patients (conscious or unconscious) with a suspected foreign-body obstruction of the airway. They are not effective for partial or complete airway obstruction due to swelling, secretions, or bleeding (e.g., smoke inhalation) or blunt neck or facial trauma. Chest compressions are performed as outlined for CPR (see page 114, Cardiopulmonary Resuscitation).

Oral airway (oropharyngeal airway or OPA)

The oral airway is usually a semi-circular hollow plastic device that, when inserted in the proper position, will help maintain a clear airway (see Figure 5-4 Oropharyngeal airway). It also has the advantage of keeping the patient's mouth open to enable the attendant to clear the airway with the index finger or with a suction device. For the patient who must be managed in the lateral position because of profuse bleeding or vomiting, the oral airway will aid in drainage. The lateral and ¾-prone positions are effective for drainage only if the patient's mouth is kept open.

Figure 5-4 Oropharyngeal airway

An attempt should be made to insert an oral airway in all patients who are unresponsive to verbal stimulation.

This is usually done during the airway assessment of the primary survey, however, the patient may still have a gag reflex and may not tolerate the oral airway. If the patient's level of consciousness deteriorates at any time, another attempt should be made.

The proper size for an oral airway can be estimated by matching the distance from the corner of the mouth to the angle of the jaw with the curved part of the oral airway (see Figure 5-5 Measurement for the airway size). The size will differ from person to person, depending on the size of the jaw and tongue and the shape of the teeth and palate. Once the correct size has been determined, there are two ways to insert an oral airway.

Figure 5-5 Measurement for the airway size

A common method is to open the mouth with a tongue jaw lift, then insert the oral airway upside down with the curved part of the airway against the tongue, sliding the end along the roof of the mouth (see Figure 5-6 Insert airway). When it is almost completely inserted, rotate the airway 180 degrees so that the curved part of the airway is resting against the palate and it slips into position behind the tongue (see Figure 5-7 Rotate airway 180 degrees and Figure 5-8 Listening and feeling for air movement).

An alternative method is to open the mouth with a tongue depressor and push the tongue out of the way, then under direct vision insert the oral airway directly into position.

Figure 5-6 Insert airway

Figure 5-7 Rotate airway 180 degrees

Figure 5-8 Listening and feeling for air movement

Cautions:

- If resistance is felt, remove the oral airway and try again. Resistance may be due to improper sizing or placement, the presence of foreign matter, or swollen tissues.
- Do not insert the oral airway in the presence of large pieces of vomitus, broken teeth, or large blood clots, as this may cause complete airway obstruction.
- If the patient gags or spits out the oral airway, remove it, because it may cause retching and vomiting.
- After insertion, assess for a clear airway (see Figure 5-8 Listening and feeling for air movement).
- Remember the following key points, because an oral airway inserted incorrectly may cause a complete airway obstruction:
  - The flange of the airway must remain outside the lips (see Figure 5-9 Airway inserted in proper position).
  - Do not use excessive force.

The oral airway may become obstructed with foreign matter or blood clots; therefore, movement of air should be monitored regularly. The oral airway must be cleaned or replaced as necessary.

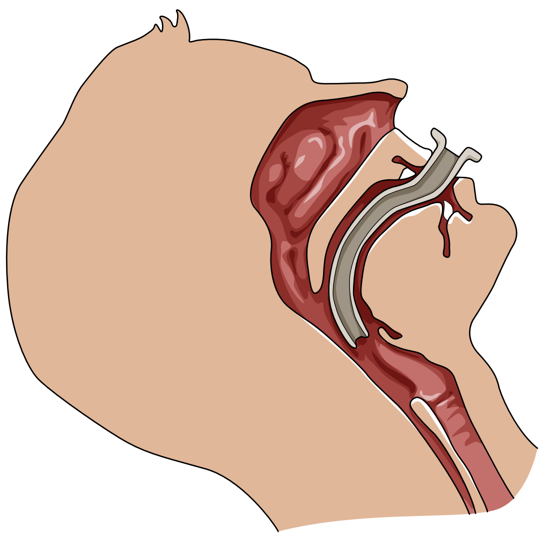

Figure 5-9 Airway inserted in proper position

Suctioning and Suction Devices

Patients with a decreased level of consciousness may lose voluntary control of their muscles. For the same reasons that allow the tongue to fall back and obstruct the airway, the epiglottis, which protects the opening to the trachea and the lungs, cannot function properly. Therefore, any foreign material in the mouth such as blood, vomitus, or teeth may enter the lungs. Foreign objects such as gravel may also be inhaled and obstruct some of the larger airways within the lungs, thereby interfering with respiration. Conscious patients are usually able to clear the oral cavity on their own by spitting or coughing up the material. The patient with a decreased level of consciousness often cannot do this. It is the responsibility of the attendant to try to keep the airway clear. Drainage positions such as the lateral position are helpful. Patients with profuse bleeding of the mouth or nose, or who are actively vomiting, should be managed in the lateral or ¾-prone (drainage) position. More often than not, the material is too thick and tenacious to drain away by gravity alone.

The attendant should check the oral cavity frequently and, if necessary, clear it using a finger sweep and/or suction. Noisy breathing is often an indication that secretions are piling up in the back of the throat or in the plastic oral airway device.

Although the drainage position and finger sweep are helpful, they are not always effective. The best method is to use a manual or electric portable suction device. All industrial ambulances, advanced first aid kits, and/or first aid rooms should have one of these suction units available.

Attendants must familiarize themselves with the use of the suction device. They must periodically check the device to ensure its proper functioning and that it is rescue ready.

Difficulties with the device should be discovered prior to needing the device. Read the manufacturer's user manual before operating the device. To operate the device, the following steps are recommended:

1. Attach a clean suction tip and tubing to the machine. The preferred suction tip should be transparent, non-flexible, and of wide calibre (e.g., tonsil suction) Yankeur suction.
2. If the suction tip has a venting hole, it must be covered by the thumb or finger to ensure adequate suction at the tip (see Figure 5-10 Rigid suction tip with a venting hole). Turn the device on and test it. With the fingers off the venting hole, insert the suction into the mouth and then activate the suction by sealing the venting hole with a finger. With manual suction devices, the suctioning rate and force are controlled by manual pressure; therefore, they do not require a venting hole.
3. Turn the suction on to ensure that the device works. In the presence of thick secretions or clotted blood, etc., the suction tip may partially clog, reducing its effectiveness. The suction tip may be cleared easily by dipping it into a small container of water or saline solution, if available, while the suction is on. Manual devices should also be tested with water or saline if time allows.
4. In the presence of profuse bleeding or vomitus, the large-calibre suction tubing may have to be used directly without a suction tip to clear the oral cavity.
5. Limit suctioning to 20 seconds at a time. Remember that the device is also suctioning away oxygen. The patient may become hypoxic during the procedure. Administer oxygen and/or assisted ventilation for at least 20 seconds between suctioning attempts if the patient is hypoxic.
6. Be gentle. Aggressive suctioning at the back of the throat may stimulate retching or vomiting or cause injury. Suction only as far back in the throat as you can see.
7. Repeat the procedure as often as necessary to maintain a clear airway.
8. Suctioning is best performed with the patient

in the lateral or ¾-prone position unless they cannot be moved (e.g., the stretcher is locked down).

9. Protect yourself from the risks of bodily fluid exposure while suctioning. Use nitrile gloves, face protection such as wraparound safety glasses, goggles or a face shield, and/or a clear suction-based barrier device such as the ST-AL shield.

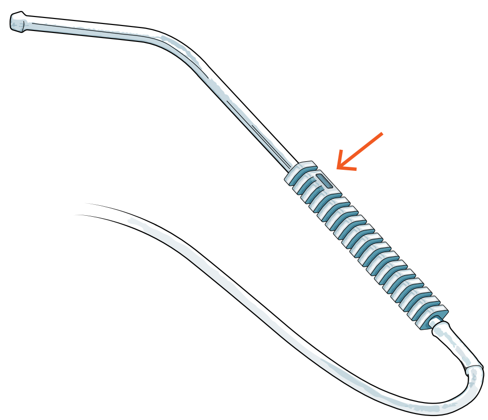

Figure 5-10 Rigid suction tip with a venting hole

Airway management: procedures for clearing the airway

Based on the mechanism of injury, the attendant must decide if there is a possibility of C-spine involvement. If the mechanism of injury suggests spinal trauma, the airway must be opened using the jaw thrust manoeuvre and patient positioning should be done with C-spine control. If the mechanism of injury does not suggest spinal trauma, the head-tilt chin-lift should be used.

Conscious — partial airway obstruction

1. Conduct the scene assessment. Activate the workplace emergency response procedures as required. Patients with persistent partial or complete airway obstruction are in the rapid transport category.
2. Assess the level of consciousness. Attempt to communicate with the patient.
3. If there is a traumatic mechanism, manually support the neck, and encourage coughing to clear foreign material from the airway.
4. If the patient is lying down, depending on the mechanism of injury, roll the patient to the lateral or ¾-prone position to facilitate drainage.
5. Use gentle suctioning, if necessary, to assist the patient to clear the airway of fluid, vomitus, or blood. Be careful to avoid causing the patient to gag or vomit.
6. If a foreign body is suspected of causing the obstruction and the patient is in severe respiratory distress with inability to clear the airway and is standing or sitting, give a sequence of back blows and abdominal thrusts until the foreign body is expelled or the patient loses consciousness. (Back blows and abdominal thrusts are ineffective for partial or complete airway obstruction due to swelling, secretions, or bleeding (e.g., smoke inhalation or gastrointestinal bleeding).
7. If partial airway obstruction persists, assist ventilation if needed according to the criteria on page 60.

Conscious — complete airway obstruction

1. Conduct the scene assessment. Activate the workplace emergency response procedures as required. Patients with persistent partial or complete airway obstruction are in the rapid transport category.
2. Assess the level of consciousness. Attempt to communicate with the patient.
3. If the patient is standing or sitting, give up to five back blows until the foreign body is expelled, the patient starts to breathe or cough, or the patient becomes unresponsive. Chest thrusts should be used for obese patients (if the rescuer is unable to encircle the patient's abdomen) or if the patient is in the late stages of pregnancy.
4. If the obstruction has not been relieved after five back blows, give up to five abdominal or chest thrusts until the foreign body is expelled, the patient starts to breathe or cough, or the patient becomes unresponsive. (Back blows and abdominal or chest thrusts are ineffective for partial or complete airway obstruction due to swelling, secretions, or bleeding (e.g., smoke inhalation or gastrointestinal bleeding.)
5. Repeat the sequence of up to five back blows and up to five abdominal or chest thrusts until the foreign body is expelled, the patient starts to breathe or cough, or the patient becomes unresponsive.
6. If the obstruction has not been relieved and the patient becomes unresponsive, position the patient supine, update emergency health services, and start CPR with 30 chest compressions. Request an AED if available.

7. After chest compressions, look in the mouth, remove anything seen, and attempt ventilation. If the chest rises when ventilated but the patient does not begin to breathe spontaneously, ventilate again and if the patient is not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, the attendant will initiate CPR/AED according to Part 5, Chapter 13.
8. If unable to ventilate, recheck the jaw thrust or head-tilt position and attempt to ventilate again.
9. If still unable to ventilate, repeat the sequence starting with 30 chest compressions.
10. After chest compressions, look in the mouth, remove anything seen, and attempt ventilation.
11. If the obstruction persists, repeat steps 8 through 10 above.
12. Continue chest compressions and attempts at ventilation and have an assistant power on the AED when it arrives; follow the voice prompts and apply the AED pads to the patient's bare chest.
13. If the obstruction is relieved and the patient is unresponsive and not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest and CPR/AED should be initiated.
14. If the patient is breathing normally but is still unresponsive to verbal stimuli, attempt to insert an oral airway, assist ventilations according to the criteria on page 60, and apply oxygen as required.
15. Complete the primary survey, and initiate rapid transport procedures.

Unresponsive — complete airway obstruction

1. Conduct the scene assessment. Activate the workplace emergency response procedures as required. Patients with persistent partial or complete airway obstruction are in the rapid transport category.
2. Assess the level of consciousness. Attempt to communicate with the patient.
3. Position the patient supine as necessary and open the airway. Assess for breathing and pulse for 5-10 seconds.
4. If the patient is not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest and CPR should be initiated. Request an AED if available.
5. After 30 chest compressions attempt to ventilate. Chest compressions may dislodge a foreign body. If the attendant is unable to ventilate, resume CPR (chest compressions are ineffective for partial or complete airway obstruction due to swelling, secretions or bleeding (e.g., smoke inhalation or gastrointestinal bleeding).
6. After chest compressions, look in the mouth, remove anything seen, and attempt ventilation. If the chest rises when ventilated but the patient does not begin to breathe spontaneously, ventilate again and check the carotid pulse for up to five seconds — if the patient is hypothermic, up to 30 seconds. If the patient is unresponsive and not breathing or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest; resume CPR.
7. If unable to ventilate, recheck the jaw thrust or head-tilt position and attempt to ventilate again.
8. If still unable to ventilate, repeat the sequence of up to 30 chest compressions, look in the mouth, remove anything seen, and attempt ventilation.
9. If the obstruction persists, repeat steps 7 and 8 above.
10. Continue chest compressions and attempts at ventilation and have an assistant power on the AED when it arrives; follow the voice prompts and apply the AED pads to the patient's bare chest.
11. If the obstruction is relieved:
    a. Give two breaths. Watch for the chest to rise.
    b. If the patient is not breathing normally, check the carotid pulse for up to five seconds — if the patient is hypothermic, up to 30 seconds. If the patient is unresponsive and not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest; initiate CPR and AED procedures.

c. If the patient is breathing normally, assist ventilation if needed according to Criteria for Assisted Ventilation (page 60).
d. If the patient is breathing adequately but still unresponsive to verbal stimuli, attempt to insert an oral airway, apply oxygen as required, complete the primary survey, and initiate rapid transportation procedures.

Unresponsive — partial airway obstruction due to fluids

1. Conduct the scene assessment. Activate the workplace emergency response procedures as required. Patients with persistent partial or complete airway obstruction are in the rapid transport category.
2. Assess the level of consciousness. Attempt to communicate with the patient.
3. If the airway is obstructed by blood, secretions, or vomit (indicated by obvious fluids in the mouth or gurgling noise or bubbles when the patient tries to breathe), depending on the mechanism of injury, roll the patient to the lateral or ¾-prone position and use finger sweeps and/or suction to clear the airway. Assess the airway in the lateral or ¾-prone position.
4. If the airway clears, indicated by the patient breathing normally or the mouth being clear of fluids:
   a. Position the patient supine
   b. Open the airway
   c. Assess for normal breathing. If the patient is not breathing normally, or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest. In this situation, CPR is initiated according to Part 5, Chapter 13.
   d. Assist ventilation if needed according to Criteria for Assisted Ventilation.
   e. If the patient is breathing adequately but still unresponsive to verbal stimuli, attempt to insert an oral airway, apply oxygen as required, complete the primary survey, and initiate rapid transportation procedures.
5. If the airway does not clear and the patient is not breathing normally, initiate CPR and AED procedures. Rolling the patient lateral and sweeping to clear the airway between sets of chest compressions may be necessary.
6. If the airway does not stay clear but the patient is breathing normally, the patient will have to be managed and transported in the lateral or ¾-prone position. Assist ventilation if needed according to Criteria for Assisted Ventilation using finger sweeps and/or suction to clear the airway as required. If the patient is breathing adequately but still unresponsive to verbal stimuli, attempt to insert an oral airway, apply oxygen as required, complete the primary survey, and initiate rapid transportation procedures.
7. If the airway continues to be partially or completely obstructed to the point where giving one ventilation every 5 seconds is not practical, give two ventilations every 10 seconds while continuing to clear the airway. Between the ventilations it may be necessary to remove and clean the oral airway, use finger sweeps and/or suction to clear the mouth, and reinsert the oral airway.
8. The patient with a decreased level of consciousness must never be left unattended in the supine position.

Assisted ventilation

The attendant may have to treat a patient in respiratory failure. Unresponsive patients with effective respirations should be monitored closely. In unresponsive patients, if respirations are absent or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, start CPR/AED. In all responsive patients with a carotid pulse but who are not breathing effectively, provide isolated assisted ventilations in the following situations:

Criteria for assisted ventilation:

- Presence of cyanosis
- Shallow and ineffective respiration
- Severe respiratory distress

Ventilation techniques

Pocket mask ventilation

Commercially designed pocket masks are particularly well suited for ventilation in the field. They have an oxygen inlet through which high-flow oxygen can be provided. They are easier to use than bag-valve mask systems. They also overcome most of the disadvantages of mouth-to-mouth ventilation as they are equipped with one-way valves to prevent contamination of the attendant with the patient's secretions (see Figure 5-11). Pocket masks without one-way valves are not recommended.

Figure 5-11 Pocket mask

Follow the steps outlined below and refer to Figures 5-12a and 5-12b:

1. Stabilize the head and neck in the neutral position if the mechanism of injury suggests spinal trauma. It is difficult to ventilate the patient effectively in the ¾-prone or lateral position; therefore, the patient must be log-rolled to the supine position unless there is active vomiting or profuse bleeding of the mouth or nose. The attendant is usually able to manually stabilize the head and neck while holding the pocket mask in the proper position Alternatively, an assistant can hold the head in a neutral position.
2. Place the mask in the proper position over the patient's nose and mouth and establish a good seal. Use two hands and the jaw thrust position. Do not tilt the head of a trauma patient with suspected cervical spine injury during ventilation.
3. Ventilate the patient once every 5 seconds, ensuring that the chest wall rises with each ventilation. If at any time the chest does not rise, do the following:
   d. Open the airway by using a jaw thrust
   e. Reposition the pocket mask to ensure a good seal
   f. Insert an oral airway
   g. Clear the airway of foreign bodies or debris
4. If the patient is breathing spontaneously, ventilate the patient once every 5 seconds timed with the patient's inhalation if possible to a combined total of 12 breaths per minute.
5. Train a helper to take over the assisted ventilation using a pocket mask.
   a. Ask the helper to watch what you are doing to ensure they understand the timing of the breathing, give one breath every 5 seconds
   b. Between breaths, explain and show the helper how to hold the mask; put their hands over yours
   c. When the helper has understood the instructions, without interrupting the assisted breathing, ask them if they can take over
   d. Watch the helper give a few breaths to ensure they are assisting appropriately — continue to coach them if necessaryIf the patient is unresponsive to verbal stimuli, insert an oral airway.
6. Open the oxygen cylinder, set the flow rate to 10 litres per minute (L/min), and connect the tubing to the inlet valve on the pocket mask. An adequate level of oxygen can still be delivered with the pocket mask if supplemental oxygen is not available.
7. If a helper is unavailable or is unable to take over the assisted ventilation, the oral airway may be inserted and oxygen applied between ventilations.

When ventilating an unresponsive patient, it may become necessary to stop assisted ventilations to begin CPR/AED. The patient should be monitored closely for signs of deterioration or improvement at least every 5 minutes. When monitoring the patient, a pulse oximeter should be applied.

Figure 5-12a Using a pocket mask with helper holding C-spine

5

Figure 5-12b Using a pocket mask from the top of patient

Bag-valve mask ventilation

The bag-valve mask system is the one most commonly used by ambulance and hospital personnel. The system requires considerable expertise, training, and practice to use effectively. This fact is often not recognized by first aid personnel. The pocket mask method is preferred for those who don't use a bag-valve mask frequently.

Figure 5-13 illustrates a typical model. The mask is triangular in shape with the apex fitting over the bridge of the nose and the base just above the chin. The attendant must ensure a tight seal for its effective use. Unless the attendant has an assistant, they should use a pocket mask. Inability to maintain the seal will result in oxygen leaking out the side and not going into the lungs, the major disadvantage of the system. Inability to seal the mask and lift the jaw with two hands normally results in an obstructed airway and inability to ventilate. If there is any difficulty using the bag-valve mask, the attendant should immediately switch to the pocket mask.

Figure 5-13 Bag-valve mask

The bag is self-inflating and is supplied with an oxygen inlet to which the oxygen tubing must be connected. The oxygen concentration of the delivered air is approximately 35 to 40%. The addition of an oxygen reservoir to the bag will increase the delivered oxygen concentration to 90%. Generally, if a patient is sick enough to require bag-valve mask ventilation, the patient will likely need maximum oxygenation; use of a bag-valve mask with an oxygen reservoir is recommended. The mask should be transparent to enable the attendant to monitor for vomitus or bleeding.

Connected to the bag is the valve. This is a one-way valve allowing oxygen to flow into the mask when the reservoir bag is compressed. When the bag is released, the bag self-inflates with oxygen from either the oxygen reservoir or directly from the oxygen cylinder. The valve closes when the patient exhales and the carbon dioxide vents to the atmosphere, not back into the bag. Some systems are not equipped with a valve and the bag is connected directly to the mask. These systems are not recommended.

Follow these steps when using the bag-valve mask system.

1. The patient's head and neck must be stabilized in a neutral position if the mechanism of injury suggests spinal trauma. A simple technique is for the attendant to stabilize the patient's head and neck between their knees while kneeling (see Figure 5-14 Using a bag-valve mask). This method frees up both hands to seal the mask to the patient's face. Alternatively, an assistant can hold the head and neck in the neutral position while the attendant holds the mask with both hands and another assistant ventilates the patient. If the patient is in transport, the attendant will most likely have to ventilate the patient from the side of the stretcheror cot.
2. Transfer the oxygen tubing from the pocket mask to the bag-valve mask and increase the oxygen flow to 15 L/min if a reservoir is being used with the bag-valve mask.
3. Place the mask in the proper position on the patient's face with the apex over the bridge of the nose and the base below the lower lip against the chin. Maintain a good seal by holding the mask snugly against the patient's face with two hands on either side of the mask.
4. An assistant should be asked to compress the bag while the attendant holds the mask with both hands and maintains the seal. Ensure the bag is compressed with just enough force to see the chest rise with each

ventilation. The two most common reasons for inadequate ventilation with this device are failure to maintain a proper jaw position and failure to maintain an effective seal. These are corrected by pulling up on the mandible and repositioning the mask and ensuring two hands are used to hold it in place.

5. Do not tilt the head of a trauma patient with suspected cervical spine injury during ventilation. Remember to maintain the head and neck in a neutral position. In patients not suspected of cervical spine trauma, the head may be tilted if necessary.
6. Ventilate the patient once every 5 seconds, timed with the patient's inhalation if possible. If the responsive patient is breathing at a rate of fewer than 10 breaths per minute, add additional ventilations between the patient's own breaths to a combined total of 12 breaths per minute.
7. Ensure that the chest wall rises with each ventilation. If the chest does not rise, do the following:
   a. Open the airway by using a jaw thrust
   b. Reposition the mask to ensure a good seal
   c. Reposition the oral airway
   d. Clear the airway of foreign bodies or debris.
8. If the ventilation is not effective, return to ventilating the patient with the pocket mask.

When ventilating an unresponsive patient, it may become necessary to stop assisted ventilations to begin CPR/AED. The patient should be monitored closely for signs of deterioration or improvement at least every 5 minutes. When monitoring the patient, a pulse oximeter should be applied.

Figure 5-14 Using a bag-valve mask

5

Respiratory emergencies

An attendant may be called to help a patient with breathing difficulties. This chapter provides an overview of workplace respiratory emergencies, as well as examples of common medical conditions that can result in shortness of breath.

Dyspnea

Dyspnea is defined as difficult or laboured breathing. The patient with dyspnea feels short of breath. This is a serious condition and is often terrifying for the patient.

Dyspnea can have several causes (traumatic and non-traumatic). Major conditions are described later in this chapter.

- There may be inadequate oxygen in the air breathed.
- There may be an obstruction to the flow of air in the upper airway, trachea, or the bronchi. Dyspnea may occur in cases of trauma, aspiration of vomitus or blood, or when a foreign body is present.
- Air may not pass easily in or out of the air sacs in the lung (e.g., as with patients suffering from a number of conditions such as an inhalation injury or asthma).
- Injury to the chest wall may impair the normal mechanics of breathing (e.g., flail chest or multiple rib fractures).
- A lung may be collapsed and unable to expand (e.g., pneumothorax or hemothorax).
- The lung tissue may have been damaged directly (e.g., bruising, laceration).
- The lung tissue may lose its elasticity and no longer respond to the normal motions of breathing (e.g., emphysema).
- The lungs may be filled with fluid because the heart muscle has failed and is no longer able to circulate blood properly (e.g., heart failure).
- Lung tissue may be infected (e.g., pneumonia).

General principles for the management of dyspnea

1. Conduct a scene assessment. Using the priority action approach, attempt to determine the cause of the patient's dyspnea. In the absence of injury, a history may identify the cause (e.g., asthma, heart disease, allergy, infection).
2. Ensure an open airway (with C-spine control, if the mechanism of injury suggests spinal trauma)
3. If a cervical injury is suspected, position the patient (with C-spine control) supine, or lateral if necessary. If there is no concern for cervical injury, position the patient for comfort (i.e., in a semi-sitting, sitting upright, or lying position with the injured side of the chest down).
4. Assess for signs of respiratory distress or oxygen deficiency (e.g., dyspnea, gasping, or cyanosis). Assist ventilation with a pocket mask, if needed, according to the criteria on page 60. Ventilate the patient once every five seconds, timed with the patient's inhalation if possible. Train a helper to take over the assisted ventilation. If the patient is unresponsive to verbal stimuli, insert an oral airway. Administer oxygen at 10 L/min connected to the pocket mask.
5. Assess for adequate breathing (i.e., look for inadequate and/or asymmetrical chest movements, the use of accessory muscles of respiration, an overexpanded chest. An open airway does not ensure adequate ventilation. Look for open wounds or other signs of chest injury.
6. Assess the adequacy of the patient's respiration and, if necessary, intervene as in step 4 above.
7. Complete the primary survey.

Chest injuries

Injuries to the chest are of major importance because they may impair the body's ability to receive an adequate supply of oxygen. No other pre-hospital emergency situation requires more urgent treatment than a patient with a chest and/or airway injury. The magnitude of injury to the organs in the thorax cannot be determined by external appearance alone. Blunt trauma may leave only a few external marks of injury and yet there may be extensive internal damage. Unless suspected and properly treated, these injuries may be rapidly fatal. The body lacks the capacity to store oxygen. Any injury that interferes with normal breathing must be treated without delay to prevent permanent damage to cells critically dependent on a constant oxygen supply (e.g., brain and heart).

Chest injuries may initially appear minor but may rapidly prove to be major and potentially fatal. Patients with potential chest trauma should receive careful and repeated assessments. Considering the mechanism of injury (e.g., severe crush injuries) the attendant may identify patients with potentially serious internal chest injuries that are in the rapid transport category.

Characteristic signs and symptoms of chest injuries

Not all of the following signs and symptoms may be present or evident in a patient with a chest injury. They are listed as general signs and symptoms that the patient may exhibit or feel.

- Pain at the injury site
- Pleuritic pain (pain that is aggravated by breathing but is not produced by direct pressure on the chest wall at the site of the injury)
- Shortness of breath or difficulty in breathing (see page 64, Dyspnea)
- Failure of one or both sides of the chest to expand normally
- Coughing up blood
- Rapid and weak pulse
- Cool and/or moist skin
- Cyanosis (blue colour of the lips, fingernails, or earlobes)
- Subcutaneous emphysema (air under the skin tissues)
- Anxiety and fear

Chest injury classification

There are two types of chest injuries: closed (blunt) and open (penetrating).

Closed

The skin is intact in a closed chest injury; therefore, the danger of such injuries may be underestimated. Even when a wound is not open, the heart, blood vessels, and lungs may have lacerations and contusions. Blunt trauma and crush injuries cause closed chest injuries. Be suspicious for the presence of internal injuries when the patient has had a significant impact to the chest.

Open

Open chest injuries are those in which the chest wall has been penetrated, as by a knife, a bullet, or a sharp object on which the patient has fallen. Open chest injuries may also be associated with severe rib fractures, where the broken end of the rib has lacerated the chest wall and the skin. As with closed chest injuries, there may also be contusions or lacerations of the heart, lungs, or major blood vessels. To avoid aggravating existing injuries, protruding objects such as knives and sticks must not be removed from the wound.

General principles of management of chest injuries

1. Conduct the scene assessment. Activate the workplace emergency response procedures as required.
2. Assess the level of consciousness. Attempt to communicate with the patient. If the patient is unresponsive, open the airway and check for breathing and a carotid pulse for 5-10 seconds — if the patient is hypothermic, up to 30 seconds. If the patient is not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest. In this situation, CPR is initiated according to Part 5, Chapter 13.
3. Ensure an open airway (with C-spine control if the mechanism of injury suggests spinal trauma).
4. If a cervical injury is suspected, with C-spine control, position the patient supine or in the lateral position. If there is no concern for cervical injury, position the patient for comfort (i.e., in a semi-sitting, sitting upright, or lying position with the injured side of the chest down).
5. Assess the patient for signs of respiratory distress or oxygen deficiency (e.g., dyspnea, gasping, or cyanosis). Assist ventilation with a pocket mask if needed according to the criteria on page 60. Ventilate the patient once every 5 seconds, timed with the patient's inhalation if possible. Train a helper to take over the assisted ventilation. If the patient is unresponsive to verbal stimuli, insert an oral airway. Administer oxygen at 10 L/min connected to the pocket mask.
6. Expose the chest if necessary and assess for adequate breathing (i.e., look for inadequate and/or asymmetrical chest movements, the use of accessory muscles of respiration, an overexpanded chest, open wounds, bruising, or abrasions). An open airway does not ensure adequate ventilation. The chest injuries that most often compromise breathing are

a large flail chest with pulmonary contusion, open or closed pneumothorax, and tension pneumothorax. An open chest wound should never be sealed; it should be covered with a dressing. If there is evidence of external bleeding, use a gloved hand to place a light gauze dressing on the wound to control bleeding. If air is escaping from the wound, it should be allowed to escape.
7. Assess the adequacy of the patient's breathing and, if necessary, intervene as in step 5 above.
8. Complete the primary survey.
9. During or while awaiting transport, closely monitor patients who have an open chest wound for the development of a pneumothorax, see page 69, Specific treatment of an open pneumothorax. Watch for the development of a tension pneumothorax and be prepared to remove any dressing that was applied to control bleeding to release the air under tension.
10. Stabilize impaled objects in the chest with appropriate dressings. It may help to provide support to obvious flail segments.
11. If there are secretions in the airway, encourage the patient to cough, which will help to clear the airway.

Specific types of chest injuries and their management

Rib fractures

Fracture of the ribs is a common chest injury. Rib fractures are usually caused by direct blows or compression injuries of the chest. The trauma patient with rib fractures may have associated injuries. They may have associated pneumothorax, hemothorax, and/or lung contusions. Upper ribs are fractured less often than lower ribs because they are protected by the shoulder girdle. Rib fractures may be associated with internal injuries; upper rib fractures may be associated with injuries in the mediastinum. Lower rib fractures may be associated with underlying injuries to the liver, spleen, or kidney.

Signs and symptoms of rib fractures

A patient with a rib fracture may have some or all of the general signs and symptoms of chest injury. Specific signs and symptoms of this condition may also be present, including:

- history of a blow or compression injury to the chest
- Pain at the fracture site or localized tenderness upon palpation
- Increased pain at the fracture site when breathing deeply, coughing, or moving
- The patient leaning toward the injured side, holding the affected area to keep it stabilized
- The patient wanting to remain still
- A rib deformity and/or chest wall bruising or laceration

More serious chest injuries must be suspected if any of the following general signs and symptoms are present: moderate to severe respiratory distress, cyanosis, hemoptysis (coughing up blood), or shock.

Management of rib fractures

The assessment and management of patients with a rib fracture should follow the priority action approach to the injured patient (see page 18) and the general principles of management of chest injuries as outlined on page 65.

As mentioned, the trauma patient with rib fractures often has associated internal injuries. Consequently, the attendant must regularly reassess the patient. If the lungs, heart, or vessels have not been damaged, the patient usually breathes without much difficulty and their colour remains normal. Simple rib fractures are not wrapped, strapped, or taped. If there is no concern for associated injuries (e.g., neck, back, or internal bleeding) the patient should be positioned to maximize comfort for transport to a hospital.

Fractured ribs often cannot be diagnosed without an X-ray, but undisplaced rib fractures are sometimes not initially visible upon X-ray.

Sternal fractures

A fractured sternum is a rare condition and usually indicates severe trauma to the anterior chest. Sternal injuries may be associated with injuries to the chest, neck, lungs, heart, or other mediastinal structures. Patients in respiratory distress with sternal injuries are in the rapid transport category. The patient with sternal injuries without obvious deformity or dyspnea should be treated as for a simple rib fracture.

Flail Chest

When two or more consecutive ribs are fractured in two or more places, or detached from the sternum, a segment of the chest wall may become disconnected from the rest of the bony thorax (see Figure 6-1 Flail chest).

The segment of the chest wall floating between the fractures is called the "flail" segment.

There may be movement of the flail area opposite to the remainder of the chest. When the patient inhales, the flail does not expand. When they exhale, it protrudes while the rest of the chest wall contracts (see Figure 6-2). This is called paradoxical movement.

Flail chest is a particularly serious injury. The patient with a flail chest may be breathing without difficulty or may be severely dyspneic, depending on the size of the unstable chest wall segment and on the magnitude of the underlying injury to the lung or other organs in the thorax. The degree of respiratory distress may also depend on the presence of shock. When the patient inhales, the paradoxical movement of a large flail segment reduces the volume of air entering the lungs. A force sufficient to cause a flail segment is usually severe enough to produce bleeding of the lungs.

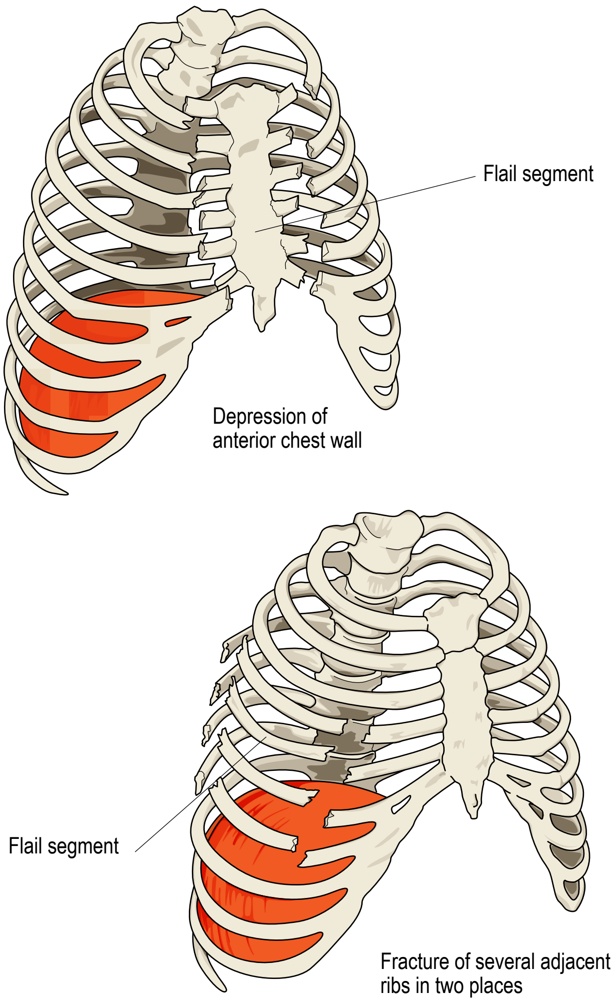

Figure 6-1 Flail chest

All cases of flail chest should be considered life-threatening emergencies. Even patients who appear stable may rapidly develop shock and severe respiratory distress. In the presence of a flail chest, the attendant should always assume that there are more serious injuries underneath.

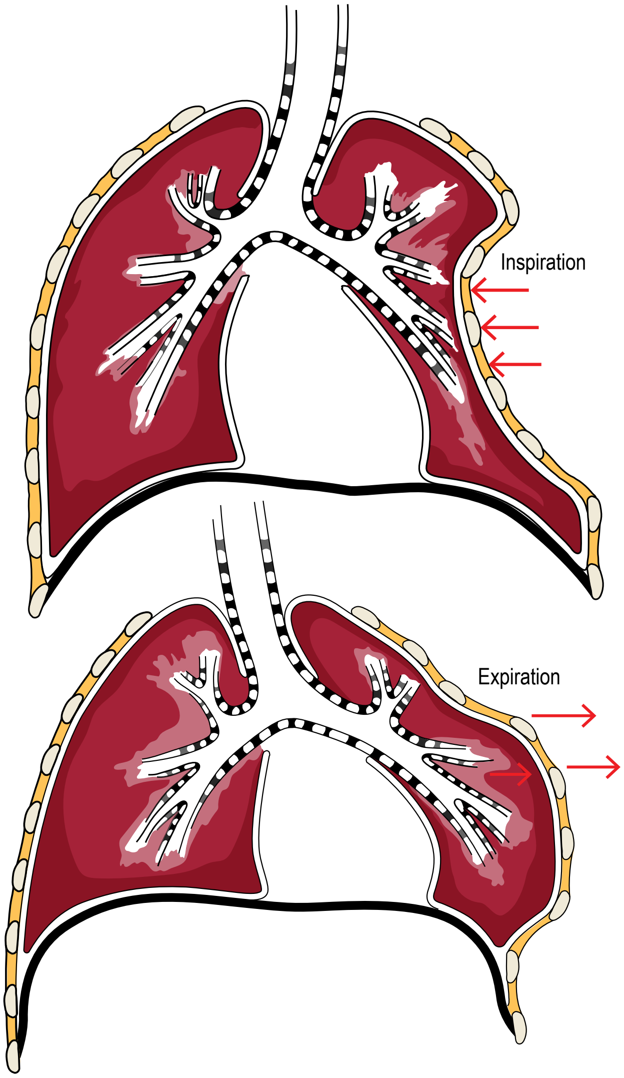

Figure 6-2 Paradoxical movement

Signs and symptoms of flail chest

A patient with a flail chest may have some or all of the general signs and symptoms of chest injury. Specific signs and symptoms of this condition may also be present, including:

- History of blunt trauma to the chest
- Paradoxical movement or deformity, visible on observing the bare chest

- Marked shortness of breath and/or respiratory distress
- Pain in the fracture area

If the lungs are damaged, the patient may:

- Cough up blood or frothy, bloody sputum
- Collapse or show signs of shock
- Show signs of tension pneumothorax

Management of flail chest

The assessment and management of patients with a flail chest should follow the priority action approach to the injured patient (see page 18) and the general principles of management of chest injuries as outlined on page 65. All patients with flail chest are in the rapid transport category.

Specific treatment of flail chest

The specific treatment of the flail chest is aimed at:

- Providing optimal oxygenation
- Restoring and maintaining stability of the chest wall

In the absence of a decreased level of consciousness, neck injury, or shock, position the patient for ease of breathing, usually semi-sitting. If necessary, the attendant must provide assisted ventilation at a rate of one breath every 5 seconds, timed to the patient's breathing pattern.

A flail segment may be supported by holding the hand firmly over the segment to help control movement.

If there is obvious paradoxical movement or instability, it may be necessary to provide further stabilization once en route.

Padding can be used to stabilize the flail segment, depending upon the size and location of the flail segment and the presence of associated injuries, particularly of the head and neck.

For flail segments located on the anterior and anterolateral chest wall, a pad large enough to cover the flail segment and no larger should be taped over the segment firmly enough to stop the paradoxical movement. Place the pad when the flail segment is sucked into its lowest point, when the chest is in full inspiration. Adhesive tape 7.5 or 10 cm (3 or 4 in.) wide should be applied over a thick, firmly rolled pad, a towel, or similar available material of the size and shape of the flail segment. The taping should be horizontal and vertical and applied generously so that it is anchored to the stable chest wall. Do not apply any fully encircling tapes or ties around the chest of an injured patient, as this will make it hard for the patient to breathe.

Do not delay transportation for the purpose of taping a pad in place. Stabilizing a flail segment in this manner can be done en route.

Closed pneumothorax

Pneumothorax occurs when lung tissue is torn and air leaks from the lung into the pleural space. Air is therefore contained within the thoracic cavity but outside the lung. When the lung collapses, its volume is reduced, thereby diminishing the amount of air that can be inhaled. As the degree of pneumothorax increases, hypoxia ensues and respiratory distress becomes evident. The patient's condition may range from a complete absence of symptoms to severe dyspnea.

A closed pneumothorax is usually caused by rib fractures. Torn lung tissue may result, permitting air to enter the pleural space. Patients with suspected pneumothorax should be assessed at a hospital.

Signs and symptoms of a closed pneumothorax

A patient with a closed pneumothorax may have some or all of the general signs and symptoms of chest injury. Specific signs and symptoms of this condition may also be present, including:

- History of chest trauma
- Pain at the site of injury
- Increased pain upon inspiration (pleuritic pain)
- Difficulty breathing (dyspnea)
- Cyanosis
- Rapid, weak pulse
- Subcutaneous emphysema at the site of injury, over the chest, or in the neck

Management of a closed pneumothorax

The assessment and management of patients with a suspected pneumothorax should follow the priority action approach to the injured patient (see page 18) and the general principles of management of chest injuries as outlined on page 65. All patients with a closed pneumothorax are in the rapid transport category.

Open Pneumothorax

With penetrating wounds of the chest wall, air enters the pleural space from outside the chest wall, thereby collapsing the lung.

Air passes back and forth through the wound on inspiration and expiration (see Figure 6-3 Open pneumothorax with punctured lung). Because this occasionally creates a sucking sound, these wounds are sometimes referred to as open,sucking-chest wounds.

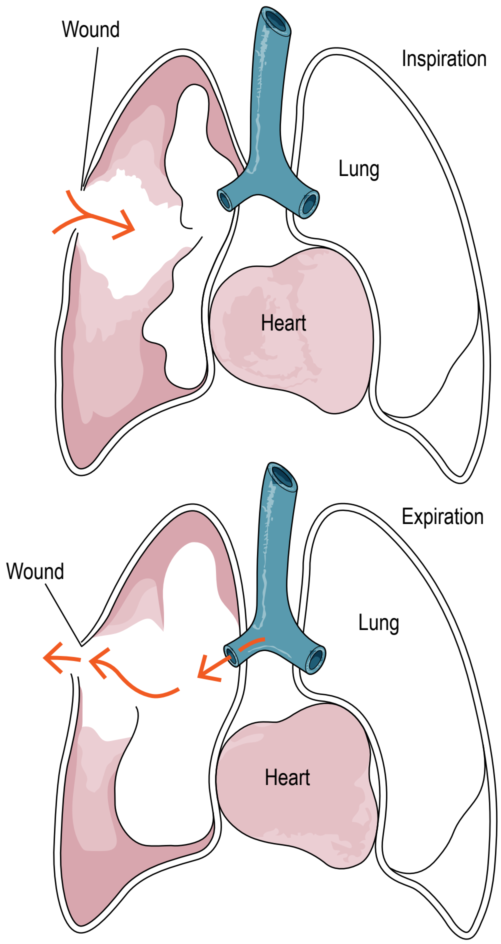

Figure 6-3 Open pneumothorax with punctured lung

Depending on the size of the opening in the chest wall, damage to underlying structures, and the pre-existing condition of the lung, the patient may have no symptoms or may be severely dyspneic. Small sucking wounds of the chest in patients with normal lungs may not cause dyspnea.

Signs and symptoms of an open pneumothorax

A patient with an open pneumothorax may have some or all of the general signs and symptoms of chest injury. Specific signs and symptoms of this condition may also be present, including:

- history of trauma to the chest
- an open chest wound
- a sucking sound as air passes through the opening in the chest wall
- blood or blood-stained bubbles expelled from the wound on exhalation
- coughing up blood
- possible exit wound

Management of an open pneumothorax

The assessment and management of patients with an open pneumothorax should follow the priority action approach to the injured patient (see page 18) and the general principles of management of chest injuries as outlined on page 65. All patients with a penetrating injury to the chest are in the rapid transport category.

If there is bleeding from the wound, apply pressure with gauze. The wound may be covered with gauze to prevent contamination from the outside environment, but it should not impede air escaping from the wound. The attendant must be aware that, regardless of the type of dressing used to treat an open pneumothorax, the dressing should not inadvertently partially or completely occlude the wound.

The attendant must be aware that, regardless of the type of dressing used to treat an open pneumothorax, the dressing may inadvertently partially or completely occlude the wound and is a serious potential complication.

Specific treatment of an open pneumothorax

The current priorities of treatment for an open pneumothorax are:

1. Control any external bleeding.
2. Do not allow the wound to seal — if the lung is still leaking air internally and cannot escape, a tension pneumothorax may occur.
3. The risks of a sucking-chest wound — where air is drawn into the chest and causes a tension pneumothorax — has been shown to be very rare. Recent research suggests that chest wounds should not be covered with completely occlusive dressings. A completely occlusive dressing over the wound may make the pneumothorax worse. The amount of pressure it takes to suck air into the chest is generally felt to be greater than the amount of pressure it takes to get air out of the chest. An occlusive dressing has a greater chance of trapping air in the chest, rather than decreasing the amount of air that is sucked in.
4. If there is bleeding from the wound, apply pressure with gauze. The wound may be covered with gauze to prevent contamination from the outside environment, but it should not impede air escaping from the wound. Otherwise, it is reasonable to leave an open chest wound exposed to ambient air without a dressing or seal.

Tension pneumothorax

Tension pneumothorax is the accumulation of air in the pleural space under pressure. The air under tension collapses the lung on the side of the injury and then displaces the mediastinum away from the air-filled pleural space, partially collapsing the other lung. Tension pneumothorax can occur from either penetrating or blunt chest trauma when the injury creates a one-way valve so that air can enter but not leave the pleural space. In blunt trauma, the lung may be torn (most commonly by a rib fracture). The site of lung injury acts as the one-way valve. It allows air into the pleural space during inspiration but prevents its return to the lung during expiration. Air under increasing pressure consequently collects in the pleural space; the resulting collapse of the lung and, particularly, the increased pressure on the heart, blood vessels, and the unaffected lung, cause severe dyspnea and shock. This increased pressure on one side of the chest can cause the neck structures to shift to one side.

Signs and symptoms of tension pneumothorax

A patient with a tension pneumothorax may have some or all of the general signs and symptoms of chest injury. Specific signs and symptoms of this condition may also be present, including:

- Severe progressive respiratory distress
- Distended neck veins due to an obstruction of the superior vena cava
- Marked overexpansion on the affected side of the chest
- Subcutaneous emphysema
- Agitation and restlessness
- A deviation or shift of the trachea away from the side of the tension pneumothorax

Management of tension pneumothorax

The assessment and management of patients with a tension pneumothorax should follow the priority action approach to the injured patient (see page 18) and the general principles of management of chest injuries as outlined on page 65. All patients with a suspected tension pneumothorax are in the rapid transport category

Specific treatment of tension pneumothorax

The patient requires expert and immediate treatment at a hospital. Management must include assisted ventilation with oxygen, if needed, according to the criteria on page 60.

Tension pneumothorax is not limited to a closed chest injury. A patient with a sucking chest wound may also have a lung laceration. If the external wound is covered by a dressing that has become occlusive, and the lung continues to leak, a tension pneumothorax may develop. Check the dressing to ensure it has not become occlusive. Posterior wounds may become occlusive if the patient is lying on the dressing. Roll the patient and remove the occlusive dressing, releasing the built up air pressure inside the chest cavity.

It must be emphasized that tension pneumothorax is one of the most serious life-threatening emergencies. Death may occur within minutes of the injury.

Because of the seriousness of these injuries, the patient may deteriorate despite the intervention provided by the attendant. The attendant must persevere and may need to provide assisted ventilation; however, excessive high-pressure ventilation may worsen a tension pneumothorax. The attendant may provide low-pressure assisted ventilation with oxygen if needed.

Spontaneous pneumothorax

A pneumothorax that develops without injury is called a spontaneous pneumothorax. Lungs can develop a weak area on their surface, either from a developmental birth defect or because of underlying disease — e.g., emphysema; see page 74, Chronic Obstructive Pulmonary Disease. The weak area ruptures and air leaks into the chest cavity, causing the pneumothorax. As the affected lung collapses, symptoms of dyspnea may appear.

Signs and symptoms of spontaneous pneumothorax

When a patient has no apparent chest injury or airway obstruction but is obviously in respiratory distress, spontaneous pneumothorax should be considered. The patient experiences a sudden sharp pleuritic chest pain with varying degrees of dyspnea.

Management of spontaneous pneumothorax

The assessment and management of patients with a suspected spontaneous pneumothorax should follow the priority action approach to the injured patient (see page 18) and the general principles of management of chest injuries as outlined on page 65. Some patients notice no particular discomfort or difficulty in breathing. However, in cases of respiratory distress, the patient is in the rapid transport category.

Management should include oxygen at 10 L/min by mask if indicated. Transport the patient to hospital in the most comfortable position, which is usually a sitting position. All cases of suspected spontaneous pneumothorax must be referred to a hospital.

Hemothorax

Hemothorax occurs when blood collects within the pleural space. It may be caused by open or closed chest injuries and is frequently associated with pneumothorax. The bleeding may come from lacerated vessels in the chest wall, from lacerated major vessels within the chest cavity itself, or from a lacerated lung. Bleeding within the thoracic cavity is hidden and often severe. Because of the capacity of the thoracic cavity to accommodate large volumes of blood, the patient may exhibit signs of shock from blood loss.

Signs and symptoms of hemothorax

A patient with a hemothorax may have some or all of the general signs and symptoms of chest injury. Of special concern with this condition are signs of increasing respiratory distress and/or shock.

Management of hemothorax

The assessment and management of patients with a hemothorax should follow the priority action approach to the injured patient (see page 18) and the general principles of management of chest injuries as outlined on page 65. All patients with a suspected hemothorax are in the rapid transport category.

Pulmonary Contusion

A pulmonary contusion is a bruise of the lung. It is almost always associated with blunt injuries to the chest — e.g., from automobile crashes and serious falls. It is similar to a bruise of any other tissue. The blood vessels in the lung are injured and a considerable amount of blood may be lost into the lung tissue. The patient may or may not be in respiratory distress, depending on the extent of the contusion. Patients with significant pulmonary contusions frequently cough up blood. The signs and symptoms of pulmonary contusion may develop 12 to 24 hours after the injury. Some pulmonary contusions are so severe that the patient is in respiratory distress almost from the moment of injury.

Signs and symptoms of pulmonary contusion

A patient with a pulmonary contusion may have some or all of the general signs and symptoms of chest injury.

Management of pulmonary contusion

The assessment and management of patients with suspected pulmonary contusions should follow the priority action approach to the injured patient (see page 18) and the general principles of management of chest injuries as outlined on page 65. All patients with pulmonary contusion are in the rapid transport category.

Blast Injuries

An explosion can create sudden extreme changes in the air pressure in the lungs. This can damage the air sacs and produce widespread bleeding. The alveoli become filled with blood, preventing the normal exchange of gases. As fluid accumulates in the lungs, it increasingly interferes with the movement of oxygen from the alveoli into the bloodstream and the patient becomes hypoxic. Changes in lung function may not occur immediately. The process of bleeding into the lungs may occur over several hours.

Pressure waves may also strike the outside wall of the body, causing pressure changes that damage the lungs and the contents of the abdominal and cranial cavities. Heart damage is a common complication associated with blast injuries.

Signs and symptoms of blast injuries

Blast injuries vary in severity and can be fatal without any evidence of external damage to the body. A patient with a blast injury may have some or all of the general signs and symptoms of chest injury. Specific signs and symptoms of this condition may also be present, including:

- History of an explosion
- Pain in the chest and/or abdomen
- Respiratory distress
- Coughing, and frothy sputum that may be bloodstained
- Nausea or vomiting
- Shock
- A decreased level of consciousness
- Bloodshot eyes, minute red or blue spots on the face, neck and/or upper chest caused by tiny hemorrhages
- Abdominal tenderness and/or rectal bleeding
- Possible delayed onset of dyspnea, headache, chest pain, or shock
- The patient may be deaf from ruptured eardrums

Management of blast injuries

The assessment and management of patients with blast injuries should follow the priority action approach to the injured patient (see page 18) and the general principles of management of chest injuries as outlined on page 65. All patients with blast injury are in the rapid transport category.

Traumatic Asphyxia

Traumatic asphyxia is a rare condition, caused by crushing trauma to the chest. An injury of this type forces the anterior chest wall back, compressing the heart against the vertebral column. This sudden compression of the heart, especially of the thin-walled right atrium, forces the blood back into the valveless veins of the upper chest, neck, and head. The force is so great that multiple tiny hemorrhages occur in the minute veins of the skin and mucous membranes. The patient will often have bluish mottled skin on the head, neck, and upper thorax and may have subconjunctival hemorrhages. The lips and tongue may be swollen and cyanotic. This alarming appearance may or may not reflect the presence of serious underlying chest injuries — e.g., pneumothorax, hemothorax, flail chest, cardiac injury.

Signs and symptoms of traumatic asphyxia

A patient with traumatic asphyxia may have some or all of the general signs and symptoms of chest injury. Specific signs and symptoms of this condition may also be present, including:

- Purple face, neck, and shoulders
- Bloodshot eyes, which may bulge
- Crushed chest
- Cyanotic and swollen tongue and lips

Management of traumatic asphyxia

The assessment and management of patients with traumatic asphyxia should follow the priority action approach to the injured patient (see page 18) and the general principles of management of chest injuries as outlined on page 65. All patients with traumatic asphyxia are in the rapid transport category.

Smoke Inhalation

Respiratory injury from smoke inhalation is a major cause of death in patients with or without body-surface burns. Smoke is a combination of suspended particles and gaseous products of combustion. The particulate matter (soot) does not cause major respiratory problems. Problems may be caused by gases from burned plastics, sulphur and nitrogen compounds, carbon monoxide, heat, and lack of oxygen. Smoke from some burning plastics contains cyanide, which prevents the body from utilizing oxygen.

Smoke inhalation may affect the upper airway, causing inflammation and swelling in the mouth, larynx, and trachea. It may also affect the more distal portions of the lung, causing generalized inflammation and fluid formation (pulmonary edema) in the lower airways and alveoli.

Respiratory distress may be immediate or delayed. Upper airway obstruction from tissue fluids may not occur for several hours. Furthermore, pulmonary edema, which may be rapidly fatal, may not be evident for many hours. It usually occurs 8 to 36 hours after the inhalation.

Some smoke inhalation patients may not have any respiratory injury but may have cyanide or carbon monoxide poisoning. Their symptoms may be entirely non-respiratory, such as neurological (altered level of consciousness) or cardiac (chest pain).

The following information concerning smoke inhalation should be obtained and passed on to medical aid:

- Location of the worker when exposed to the smoke — a patient found in an enclosed space is likely to suffer significant inhalation injury
- Duration of exposure — a worker with very brief exposure is less likely to suffer significant injury
- Presence of toxic substances — alerting the attendant to possible respiratory irritation
- Decreased level of consciousness — may be due to hypoxia, carbon monoxide, or other toxic gases
- Any other information that might be a factor, such as head injury or alcohol use

The effect of specific respiratory toxins is covered on page 302, Poisoning by Inhalation.

Signs and symptoms of smoke inhalation

- Sore throat, hoarseness, shortness of breath, swallowing difficulties, and pain on deep inspiration
- Cough, especially when it produces soot-tinged sputum
- Headache or dizziness, restlessness, confusion,
- decreased level of consciousness, sometimes convulsions
- Respiratory distress with noisy, rapid respiration or a harsh dry cough
- Cyanotic or pale
- Facial burns, especially about the mouth and nose

Management of smoke inhalation

The attendant should not enter an area that may have a toxic atmosphere or inadequate oxygen content without wearing the proper rescue breathing apparatus. The patient should be removed from the contaminated atmosphere to fresh air before the primary survey is conducted. If available, and there are no sources of ignition present, then provide supplementary oxygen at 10 L/min in cases of smoke inhalation. Remember, pulse oximetry readings can be misleading with toxic smoke inhalation. Readings are falsely elevated by CO-bound hemoglobin (carboxyhemoglobin).

The assessment and management of patients with smoke inhalation should follow the priority action approach to the injured patient (see page 18) and the general principles of management of chest injuries as outlined on page 65. All patients suffering from smoke inhalation are in the rapid transport category.

Asthma

The term asthma is derived from a Greek word meaning breathlessness. The chief symptom of asthma is dyspnea or difficulty breathing (see page 64, Dyspnea). It is a disease characterized by attacks of narrowing of the airways that occur intermittently and may range from mild attacks of shortness of breath to profound respiratory failure and death. The asthma attacks are interspersed with symptom-free periods. It is the narrowing of the airways (bronchospasm) that produces the typical wheezing, whistling noises of breathing during an asthmatic attack.

Asthma affects approximately 5% of adults and up to 10% of children in the United States and Canada. Although mortality from asthma is relatively low, the disability it causes is very great. It accounts for a significant number of days lost from work and/or restricted activity.

The chief characteristic of asthma is its periodic reversible acute attacks of bronchospasm. The bronchospasm is caused by the contraction of the smooth muscles of the walls of the airways (bronchi and bronchioles), which leads to the airways' constriction. Narrowing of the airways in this fashion impairs ventilation.

During an asthma attack, in addition to the widespread bronchial constriction, edema forms in the mucous membrane of the airways and the numerous glands in this membrane produce copious amounts of very sticky secretions. These changes further narrow the airways and interfere with ventilation. The greatest interference with airflow is during expiration. Consequently, air enters the alveoli and becomes trapped. The volume of air in the lungs builds up progressively and the patient works increasingly harder to push each breath out. As the disturbance progresses, both inspiration and expiration become increasingly difficult. The sensation that the patient's air supply is being shut off frequently induces a state of apprehension and anxiety, which may progress to panic.

Often, patients are able to get enough oxygen into the system so as to not be hypoxic, but have a hard time exhaling carbon dioxide, which builds up in the blood. Very high levels of carbon dioxide leads to changes in mental status, causing confusion and altered level of consciousness. This disturbed mental state aggravates the respiratory attack and impairs respiratory drive. This failure of proper air exchange eventually causes reduced oxygen in the blood. Beware of the hypoxic, confused asthmatic — they are very sick.

The bronchial smooth muscles in asthmatics are sensitive to various stimuli. Different factors cause acute asthmatic attacks in different individuals, but such factors may include:

- Allergic reactions to pollens, animal dander, dust, smoke, cedar dust, isocyanates (chemicals used in paints and resins), etc.
- Respiratory infections — e.g., from cold viruses
- Cold air
- Medication — e.g., Aspirin
- Emotional distress
- Exercise
- Other irritants

Asthma attacks may be part of a serious allergic reaction — e.g., following a bee sting — and may progress rapidly to anaphylactic shock (see page 100, Anaphylactic Shock). It is important to find out what precipitated the attack and whether the patient has a history of recurrent attacks of a similar kind but can breathe normally in between.

To reverse the constriction of the bronchi from the attack, many patients with asthma have their own prescription medications (bronchodilators), often in the form of sprays (inhalers). There may be oral medications as well. The medications may be administered with the attendant's assistance. If possible, a history of all medications and the amount used for the current attack should be provided to hospital staff.

Status asthmaticus

Status asthmaticus occurs when the patient has a severe, prolonged asthmatic attack that has not responded to the usual medications. The history may reveal that the attack has persisted for several hours. The patient is usually exhausted and dehydrated. The chest is usually very overinflated and exhibits minimal movement with respiratory effort. Even wheezing may not be heard (silent chest) because there is virtually no air moving through the swollen, narrowed airways; this is a bad sign as it indicates an imminent respiratory arrest. The patient may appear sleepy, as the accumulated carbon dioxide in the blood will sedate the patient, the respiratory drive falls, and chest muscles fatigue from continued overexertion, adding to the respiratory failure.

These patients have a life-threatening medical emergency and are in the rapid transport category.

Recognition of the acute asthma attack

History

- Precipitating factors — e.g., cedar dust, pollens
- Previous attacks
- Medication (inhaler or pills)
- Dyspnea

Physical findings

- Respiratory distress (the patient sits upright and may lean forward, fighting for breath)
- A non-productive cough that may produce scant amounts of very thick whitish-yellow mucous
- Overinflated chest with prolonged expiration, and the movement of the chest wall may diminish as the attack becomes more severe
- Whistling, wheezing breathing, usually more evident on expiration
- Anxiety — some patients may be very frightened and struggling for breath
- The respiratory rate and pulse rate are usually elevated

Management of the asthma attack

1. Calm and reassure the patient.
2. Maintain and support the patient in the most comfortable sitting position.
3. If indicated, do not delay in providing oxygen unless you can quickly prove that the patient has normal oxygen saturations.
4. Help the patient to take their medication. If the cause of the attack is an allergen, and the patient uses an epinephrine auto-injector, they may need assistance in getting it.
5. Assist ventilation with a pocket mask and oxygen if the patient is sleepy or unresponsive, or according to the criteria on page 60.
6. All asthma patients in respiratory distress are in the rapid transport category. An asthma patient who is drowsy, exhausted, or dyspneic with a prolonged attack has a life-threatening medical emergency.

Chronic obstructive pulmonary disease

Chronic obstructive pulmonary diseases (COPDs) are long-standing obstructive airway diseases characterized by diffuse obstruction to airflow within the lungs and dyspnea, both due to the destruction of lung tissue. The most common forms of COPD are emphysema and chronic bronchitis. They are usually caused by exposure to lung toxins, such as smoking or some chemicals/particles in the environment. Most sufferers have a combination of both emphysema and chronic bronchitis and may also have some superimposed asthma.

Individuals with chronic obstructive lung disease are usually older and have a long history of respiratory problems. These diseases affect more than one-fifth of all North American adults and account for a great many lost workdays. The most important causative factor in producing COPD is cigarette smoking.

Emphysema

Emphysema refers to a chronic permanent destructive change in the alveoli, resulting in loss of their elasticity. The alveoli become distended with trapped air and cease to function. The walls of such affected alveoli often break down to produce larger air-containing sacs with thickened walls that do not participate in oxygen or carbon dioxide transfer. It is similar to slowly filling the thorax with small balloons that do not function as lungs. Consequently, over time, there is a dramatic decrease in the total number of alveoli, making it more difficult for the patient to breathe and reducing their respiratory reserve significantly. Less oxygen is able to travel through the alveolar walls and, hence, into the blood, which greatly diminishes the patient's exercise tolerance. The bronchioles are also destroyed in the same fashion as the alveoli, causing further air trapping and dyspnea.

Recognition of emphysema

History

- Usually a long history of cigarette smoking
- Patients are usually thin, with a history of weight loss from increased respiratory muscle use; breathing harder than normal burns more calories
- A history of increasing dyspnea on exertion over
- months or years
- A history of sudden increasing shortness of breath, which may be associated with a recent chest cold, and the sputum may have recently changed colour to grey, green, or yellow
- Medication in the form of inhalers and/or pills

Physical findings

- Respiratory distress, with the patient hunched forward in a sitting position (see Figure 6-4 Patient with emphysema)
- Often, an overinflated barrel chest in a thin individual
- Little chest movement with respiration and the patient is often using accessory muscles of respiration, involving the neck, clavicles, and shoulders
- Prolonged exhalation with audible wheezing, and the patient may purse their lips during exhalation
- Increased respiratory rate and tachycardia (heart rate greater than 100 beats per minute)
- The patient may be drowsy from hypoxia or carbon dioxide retention
- Often, patients are not cyanotic and tend to pink up with the administration of oxygen

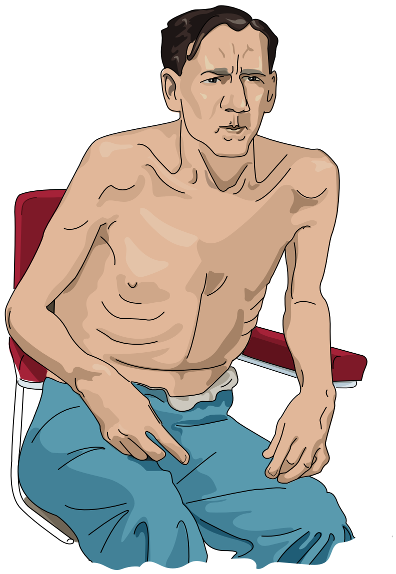

Figure 6-4 Patient with emphysema

Chronic bronchitis

This condition is characterized by recurrent infections involving the bronchial tree. Usually, the history of heavy cigarette smoking for many years produces inflammation, swelling, and excessive mucous in the airways. Because of airway disease, airflow to the alveoli is impaired, which impairs ventilation. Commonly, the patient with chronic bronchitis has an associated heart disease and may develop congestive heart failure.

Recognition of the patient with chronic bronchitis

History

- Often, a long history of cigarette smoking and recurrent respiratory infections
- History of productive cough for several months in each of the two previous years
- Cough and dyspnea are made worse with exertion — e.g., walking up stairs
- A history of sudden increasing shortness of breath, which may be associated with a recent chest cold,
- and the sputum may have recently changed colour to grey, green, or yellow
- Medications in the form of inhalers and/or pills

Physical findings

- Respiratory distress
- Often, cyanotic individuals may appear overweight and out of shape
- There may be an audible wheezing respiration with prolonged expiration and recurrent
- productive cough
- Respiratory rate is increased and there is usually tachycardia
- The neck veins may be distended

Most patients with COPD have some history and physical findings of both conditions. The patient with established COPD is prone to recurrent bouts of deterioration. This is usually precipitated by an additional stress such as a cold or flu. The patient will present with acute respiratory distress.

Management of patients with COPD who are deteriorating

Field management of COPD patients with acute respiratory distress is aimed at relieving hypoxia, then transporting rapidly to medical aid. Normal individuals are stimulated to take a breath when the amount of carbon dioxide in the blood is increased only slightly. Falling oxygen levels are not the primary stimulus until they have dropped to a considerably lower level.

A small minority of patients with advanced COPD lose their sensitivity to carbon dioxide and breathe as a consequence of low blood oxygen levels — i.e., by a hypoxic drive. Whereas most people with normal lungs at sea level have oxygen saturations (SpO_2) above 94%, patients with COPD may function normally with oxygen saturations of 88–92%. Because of the destruction in the lung tissue in patients with COPD, carbon dioxide does not readily diffuse out of the blood into the lung alveoli. Over the years, such patients develop increasing amounts of carbon dioxide in the blood, desensitizing the respiratory centre in the brain to its presence. The condition also hampers the diffusion of oxygen into the blood and these patients usually have below-normal blood oxygen levels. The low oxygen level triggers each breath in these patients, but this hypoxic drive is not nearly as sensitive as the carbon dioxide stimulus to breathe is in normal people. The oxygen level in the blood of COPD patients must fall to almost half the normal amount before they are stimulated to take another breath.

If such a COPD patient breathes high levels of oxygen, their main physiologic drive to breathe is removed, and the ventilation rate slows. In fact, the patient may not take another breath for some time; this is called oxygen apnea. The decrease in breathing causes the carbon dioxide to accumulate to even higher levels, leading to central nervous system depression. If the high oxygen treatment is continued, the patient will become confused, then lapse into coma and may go into respiratory arrest. The process is called carbon dioxide narcosis. As previously mentioned, this condition is found in a relatively small number of patients with advanced chronic obstructive lung disease. Such patients are unlikely to be working at any type of job requiring exertion, owing to their complete lack of exercise tolerance. Consequently, they are unlikely to be found in a workplace doing any job requiring activity.

The attendant must watch for any evidence of respiratory depression and be prepared to assist ventilation if necessary.

Treating COPD patients

1. Calm and reassure the patient.
2. Ensure that there is an adequate airway.
3. Maintain and support the patient in the position of greatest comfort.
4. If unable to measure oxygen saturations, administer oxygen at a flow of 1 to 2 L/min in most circumstances for the patient with suspected advanced chronic obstructive lung disease. If you are able to measure oxygen saturations, administer titrated oxygen to provide oxygen saturations of around 92–95%. Assist ventilation if needed according to the criteria on page 60. Check SpO_2 after 5 minutes.
5. Assist the patient in taking prescribed medications.
6. Check the vital signs every 10 minutes. Of most importance are the respiratory rate and level of consciousness. The slowing of respiratory rate and/or decrease in awareness are usually early signs of impending carbon dioxide narcosis.
7. If a COPD patient's respiratory condition deteriorates and the patient shows increasing dyspnea despite 1–2 L/min of oxygen, increase the concentration gradually at a rate of 1 L/min every 5 minutes, or until blood oxygen saturation is greater than 95%. Continue to monitor the patient's respiratory rate and depth. Be prepared to assist ventilation if respiration becomes depressed or the level of consciousness deteriorates.
8. Never stop oxygen therapy abruptly once it has been initiated; it should be tapered off.
9. If the patient is suspected of developing carbon dioxide narcosis, oxygen should not be completely removed. Decrease the oxygen flow rate and prepare to assist breathing with bag-valve mask.
10. The patient should be encouraged to cough and clear secretions.
11. Patients with deteriorating COPD are in the rapid transport category.

Pneumonia

One of the most common diseases affecting the respiratory tract is pneumonia. Although this is frequently thought of as a single disease, it is actually a group of diseases affecting the lung, sometimes in different ways. There are many varieties of the disease: lobar pneumonia, bronchopneumonia, and viral pneumonia are among them.

The principal characteristic in all the pneumonias is an exudation of serum and cells into the alveolar spaces and small bronchioles. Associated with the infection is the slowing down of the blood supply surrounding the alveoli and a thickening of the alveolar walls by fluid and cells that escape from the capillaries. Pneumonia produces hypoxia in all cases. If enough lung tissue is involved, cyanosis is produced and is accompanied by rapid and shallow respiration, weakness, and symptoms of oxygen deficiency.

Prior to the use of antibiotics, pneumonia was one of the most common causes of death. In those days, pneumonia was a process that dragged on for one to three weeks and recovery depended upon the patient's ability to survive a severe respiratory handicap.

Today, the illness usually lasts a much shorter time and has an excellent outcome, provided appropriate care is given. The course of the disease varies with the type of pneumonia and with the drugs currently available. The severe disturbance, generally speaking, does not last very long, although very aggressive and virulent organisms can produce pneumonia that causes death, even today. Serious cases require admission to hospital and aggressive treatment with intravenous antibiotics, physiotherapy, oxygen therapy, and, at times, mechanical respiratory support. It is important that the attendant refer any individual with a suspected pneumonia for medical attention.

Recognition of the patient with pneumonia

History

- Cough
- Fever, chills
- Sputum production, usually greenish-yellow
- Pleuritic chest pain
- Dyspnea

Physical findings

- Fever
- Tachycardia
- Respiratory distress
- Cyanosis, if the pneumonia is severe

Management of Patients with Pneumonia

The management of patients with pneumonia includes the maintenance of the ABCs, assessing the vital signs, and transporting the patient to medical aid. If applicable, do not delay in providing oxygen unless you can quickly prove that they have normal oxygen saturations.

Pulmonary edema

Dyspnea can be caused by acute pulmonary edema. Pulmonary edema is the accumulation of fluid within the alveoli, causing impairment of the flow of oxygen from the alveoli into the blood. With the presence of fluid in the alveoli, the lung tissue becomes stiffer and the patient must work harder to breathe. Similarly, the fluid collection is not limited just to the alveoli but may also occur in the walls of the smaller bronchioles, causing them to become narrower. This process is often associated with bronchospasm, as described earlier (see page 73, Asthma), with further impairment of the respiration. It also accounts for the wheezing respiration that may occasionally be present in some patients with pulmonary edema.

The most common cause of pulmonary edema is left ventricular failure. This is discussed on page 112, Congestive Heart Failure. Several other causes of pulmonary edema are referred to in other chapters. Such causes include inhalation of noxious gases — e.g., chlorine gas — (see page 302, Chlorine Gas) and smoke inhalation (see page 72, Smoke Inhalation). Other less common causes of pulmonary edema include acute altitude sickness and overdose with some substances — e.g., heroin or aspirin.

Recognition of Acute Pulmonary Edema

History

- If the pulmonary edema is caused by left ventricular failure, there may be chest pain with an associated heart attack, history of high blood pressure, or history of previous attacks of pulmonary edema.
- The patient may have been exposed to other precipitating factors such as chlorine gas, smoke inhalation, near-drowning, drug overdose, high altitude, or aspiration.
- There may be dyspnea, often severe, with the inability to lie down.

Physical findings

- Increasing respiratory distress, and the patient may be agitated, restless, or confused.
- Cold, clammy skin and distended neck veins if there is a cardiac origin.
- Cyanosis.
- Tachycardia.
- Cough, producing frothy white or pink sputum.
- Wheezing respiration.

Management of pulmonary edema

1. Calm and reassure the patient.
2. Position the patient sitting upright in the position of comfort, with the legs dangling, if possible.
3. If applicable, do not delay in providing oxygen unless you can quickly prove that they have normal oxygen saturations.
4. Periodic rapid suctioning of the airway may be necessary for accumulated secretions if the patient cannot clear them.
5. If the patient is becoming drowsy or has severe respiratory distress, assisted ventilation timed to the patient's breathing, with oxygen at 10 L/min.
6. The comatose patient with acute pulmonary edema will require oral airway placement, suctioning, and assisted ventilation with oxygen.
7. Patients with pulmonary edema are in the rapid transport category.

Hyperventilation syndrome (panic attack)

The term hyperventilation syndrome means breathing at a depth or rate greater than needed to control normal carbon dioxide levels in the blood.

Dyspnea may occur in patients without any lung abnormalities or medical problems. Often, anxious people or individuals with unusual stress may unconsciously start to breathe at a rate and depth greater than needed physiologically. The patient is often unaware that they are breathing abnormally, deeply, or rapidly. Such breathing causes a lowering of the normal carbon dioxide levels in the blood which, if it continues, causes an alteration in the body chemistry (alkalosis). This alkalosis produces a number of characteristic signs. All or only some of these findings may be found in any one patient.

Hyperventilation may also be a symptom of some more serious disease process, such as diabetic ketoacidosis, drug overdose, heart attack, or some form of lung disease.

Recognition of hyperventilation

History

- Marked anxiety and even panic — e.g., the patient may feel as though they are going to die
- Feelings of dizziness, or a sense that the patient's eyes are not quite in focus
- A feeling of depersonalization (the patient may feel detached, unreal, and not fully in control of their body)
- Variable pressure across the chest or stabbing, fleeting chest pain
- Numbness or tingling, or feelings of pins and needles about the mouth, over the scalp, and in the fingertips and toes
- No history of significant cardiac or respiratory disease

Physical findings

- Marked shortness of breath or dyspnea, with the patient often feeling that they cannot take or get a deep enough breath
- Rapid respiration or occasional deep, sighing respiration
- Tachycardia
- Rarely, a brief faint but no seizure activity
- In advanced attacks, carpopedal spasm may occur, with the fingers and wrists becoming stiff and flexed like claws, and with the thumb held stiffly across the palm

Management of hyperventilation syndrome

Hyperventilation syndrome is a diagnosis of exclusion. The attendant does not have the skills required to rule out other diagnoses. Patients with hyperventilation should be treated as other patients with respiratory distress and transported to the hospital.

Calm and reassure such patients, explain what's happening with their breathing, and firmly suggest that they slow down their breathing.

Narcotic overdose

Narcotic abuse and overdose is recognized in the classic marginalized drug abuse population, but it is also recognized as a situation that may be seen in workplaces. It may go under-recognized.

Health Canada revised the federal prescription drug list on March 22, 2016, to make a non-prescription version of naloxone more accessible to Canadians in support of efforts to address the growing number of opioid overdoses. Naloxone™, or Narcan®, is an antidote to opioid overdose.

Taking too much of any opioid drug — e.g., morphine, heroin, methadone, oxycodone, and fentanyl — can make breathing slow down or stop. Naloxone reverses this, restoring normal breathing and consciousness. Giving naloxone can prevent death or brain damage from lack of oxygen during an opioid overdose. It does not work for non-opioid overdoses — e.g., cocaine, ecstasy, GHB, or alcohol. However, if an overdose involves multiple substances, including opioids, naloxone helps by temporarily removing the opioid from the equation. Naloxone can be administered using a syringe and intramuscular injection or intranasally — sprayed into the nose — using a Naloxone plunger device.

Recognition of Narcotic Ingestion

History

- Drug paraphernalia (such as needles, butane lighters, devices used as tourniquets) may be evident
- Patients may seem to be sleepy or tired, or may be deeply unconscious
- Patients may deny drug use/abuse out of fear of the consequences

Physical findings

- Decreased respiratory effort, or apnea (lack of breathing)
- Small or pinpoint pupils
- Patients may be very sweaty (diaphoretic)
- Tachycardia or bradycardia may be present
- Track marks — small holes/bruising in the veins where intravenous drugs have been injected — may be evident

The assessment and management of patients with a suspected narcotic overdose should follow the priority action approach to the injured patient (see page 18). Specific treatment for opioid overdose should include the use of naloxone.

Oxygen therapy and equipment

This chapter provides the attendant with a convenient reference for the use of oxygen-therapy equipment. The topics covered include safe handling practices, cylinders, regulators, gauges, adapters, delivery devices, operating procedures, pulse oximetry, patient application, and cleaning, care, and storage.

Basic principles of oxygen therapy

- Hyperoxia — providing excessive oxygen resulting in high O2 above physiologic normal levels — may be harmful. There is evidence that hyperoxia for patients suffering from myocardial infarction, sepsis, and intracerebral catastrophes may cause more harm than good. Equally, hypoxia — O2 levels below physiologic norms — causes harm if left untreated.
- Hypoxia should be suspected in all patients who are confused, restless, or excessively drowsy.
- For patients with symptoms of hypoxia, do not allow the hypoxia to continue. Ideally, use pulse oximetry to assess oxygen saturations, and treat accordingly. But if the attendant is unable to rapidly check oxygen saturations, and systemic hypoxia is suspected, provide oxygen. If the patient improves, then the attendant can reduce (titrate) the oxygen flow rate. You may need to change the delivery device depending on the flow rate — e.g., from simple or non-rebreathing mask to nasal cannula. The goal is to deliver oxygen in concentrations that provides the patient's tissues
- with normal oxygen saturations — the attendant should aim for an oxygen saturation above 95%.
- The body is unable to store oxygen. If oxygen is required, administer it continuously.
- Supplemental oxygen is no substitute for a clear airway. Never leave a patient with a decreased level of consciousness alone with an oxygen mask secured to their face, even when the patient is in the lateral position. If the patient vomits, they will aspirate.
- If a patient is showing marked respiratory distress, provide supplemental oxygen at a flow of 10 litres per minute (L/min) until oxygen saturations are normal. If there is a limited supply of oxygen or the patient becomes less distressed, reduce the flow accordingly and consider switching oxygen-delivery devices — e.g., nasal cannula. Assisted ventilation may also be required.
- If possible, never leave a patient with advanced chronic obstructive pulmonary disease (COPD) alone while they are receiving oxygen. Watch for signs of impending carbon dioxide narcosis, slowing of the respiratory rate, sleepiness, confusion, and decreasing level of consciousness.

Patient application

Indications for the use of oxygen

- Respiratory and/or cardiac arrest
- Hypoxic patients
- Shortness of breath — acute or chronic
- Shock
- Cardiovascular or respiratory illness
- Inadequate respiration — e.g., due to drug overdose
- Decreased level of consciousness
- Pregnant trauma patients
- All medical air evacuation patients
- All patients with decompression illness
- Potential carbon monoxide and/or toxic-smoke inhalation
- Patients with no history of COPD, with blood oxygen saturations that are below physiologic normal levels (less than 95%)

Safe handling practices

- Never use oil or grease on any device that will be attached to an oxygen cylinder. Grease or oil can violently explode if it comes in contact with high-pressure oxygen. If grease or oil is noted around or on the regulator, do not try to clean it
- but return the regulator to the nearest supplier for cleaning and repair before it is used. If grease or oil is noted on or around the cylinder valve or aperture, do not use the cylinder and immediately inform the oxygen supplier of this condition.

- Do not allow smoking around oxygen equipment that is operating. Never use oxygen around an open flame. Although oxygen will not explode or burn byitself, it does increase combustion and will cause burning objects to flame vigorously. The area where oxygen is in use must be clearly marked with signs that read “Oxygen — No Smoking.”
- Oxygen cylinders should always be well secured, preferably supported by a case in the upright position or lying horizontally. This will prevent damage to the valve assembly. Since oxygen cylinders when full contain between 2,000 and 2,200 pounds per square inch (PSI) of pressure, breaking of the valve assembly could turn the cylinder into a jet-propelled missile.
- Store cylinders that are not in use in a cool, well-ventilated room and away from any corrosives.
- Use only regulators and gauges intended for use with oxygen.
- When opening the cylinder, stand so that the cylinder valve is between you and the regulator; this could prevent injury if the regulator should explode.
- Ensure that the valve seat insert and gasket are in good condition before assembling equipment; this will prevent dangerous leaks.
- Never attempt to tighten the cylinder valve or any part of the valve. If the cylinder valve is leaking, place it well away from hazards and notify the oxygen supplier immediately.
- Oxygen cylinders are not to be refilled by unauthorized personnel. Always return empty cylinders to qualified plants for refilling.

Cylinders

Oxygen cylinders come in various sizes. The attendant is most likely to use three industrial-cylinder sizes: D (14.5 cu. ft.), E (26 cu. ft.), and K size (249 cu. ft.).

Oxygen cylinders are usually made of seamless steel, although some lightweight aluminum and carbon-fibre cylinders are in use. Two systems are used to connect the valve to the top of the cylinder, the medical-post type (see Figure 7-1) and the threaded type with a hand valve (see Figure 7-2).

Oxygen cylinders must be periodically hydrostatically tested for structural weakness, in accordance with local regulations. When sending oxygen cylinders out for refilling, the date of the last hydrostatic test that is stamped on the cylinder must be checked.

Figure 7-1 Medical post type cylinder

Oxygen cylinders being sent out for refilling should have some residual pressure left in them. It is recommended that at least 200 PSI be left.

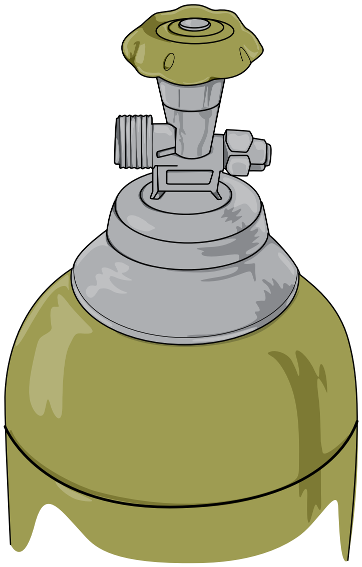

Figure 7-2 Threaded type cylinder

Cylinder duration

There are several methods of calculating how long the oxygen in the cylinder will last. One common method is based on Boyle's Law, which states that the pressure and volume of a gas are inversely proportional ($P \times V = k$).

To calculate the duration of oxygen supply, we use the following formula: Duration (T) = $k \times (P - R) \div F$

T = Duration (how long the oxygen will last)

k = Cylinder constant (specific to each cylinder type)

P = Tank gauge pressure (current pressure in the tank, in PSI)

R = Safe residual pressure (the minimum pressure to maintain safety, typically 200 PSI)

F = Flow rate (the rate at which oxygen is being used, in liters per minute)

$$\frac{\text{(Tank pressure in PSI - 200)} \times \text{cylinder constant}}{\text{flow rate L/minute}} = \text{time until cylinder is empty}$$

Example: For a D cylinder with a tank pressure (P) of 2000 PSI, a flow rate (F) of 10 liters per minute, and a residual pressure (R) of 200 PSI:

$$T = \frac{0.16 \times (2000\text{-}200)}{10} = \frac{0.16 \times 1800}{10} = \frac{288}{10} = 28.8 \text{ minutes}$$

By using this formula, a first aid attendant can estimate the remaining time for the oxygen supply, allowing them to plan ahead and switch cylinders before they run empty to ensure continuous care.

P: Tank gauge pressure (in PSI)

R: Safe residual pressure (usually 200 PSI)

F: Flow rate (in liters per minute)

k: Cylinder constant (varies by cylinder type)

T: Duration (how long the oxygen will last)

This approach helps ensure patient safety and effective oxygen management.

Table 7-1 shows the duration times of D, E, and K cylinders at various pressure levels. A copy of this table should be available in the oxygen therapy kit. The attendant must switch to a new cylinder before the one in use is empty.

The attendant must ensure there is sufficient oxygen to supply a patient, at a flow rate of 15 L/min, from the time of initial application to the arrival at medical aid plus 15 minutes. Recognize that although most oxygen meters/regulators are calibrated to go to 15, some regulators will allow the attendant to turn the flow rate dial past 15 L/min to provide more oxygen. Be aware that this increased flow rate will decrease the functional duration of the cylinder.

Regulators

Regulators can be either one stage or two stage. This refers to the number of steps required to reduce the cylinder pressure to a safe working pressure. Most regulators currently in use are two stage.

Regulators are connected to oxygen cylinders by one of two methods:

- On D and E cylinders, the regulator is connected to the cylinder by a yoke assembly. The yoke has pins that match the corresponding holes on the
- medical post. This aligns the regulator inlet with the delivery port on the medical post. This pin indexing prevents the yoke assembly from being connected improperly or to a cylinder of another type of gas.
- On the K cylinder, there is a hand valve assembly with a threaded outlet. The standard 540 thread has been adopted to avoid connecting the regulator to any other gas.

Oxygen cylinder duration

Tank Size	D Cylinder (M15)	15 cu. ft.
LB pressure	**10 Lpm**	**15 Lpm**
2,000	29 min	19 min
1,500	21 min	14 min
1,000	13 min	9 min
500	5 min	3 min
Tank Size	**E Cylinder (M24)**	**25 cu. ft.**
LB pressure	**10 Lpm**	**15 Lpm**
2,000	50 min	34 min
1,500	36 min	24 min
1,000	22 min	15 min
500	8 min	6 min
Tank Size	**K Cylinder**	**244 cu. ft.**
LB pressure	**10 Lpm**	**15 Lpm**
2,000	9 hr 41 min	6 hr 28 min
1,500	6 hr 08 min	4 hr 53 min
1,000	4 hr 18 min	2 hr 07 min
500	1 hr 56 min	63 min

Table 7-1

Gauges

Two gauges are usually attached to the regulator: a pressure gauge and a flowmeter (see Figure 7-3). The pressure gauge indicates the amount of compressed oxygen available in the cylinder in PSI. The flowmeter indicates the rate of oxygen flowing from the cylinder through the regulator to the patient in litres per minute.

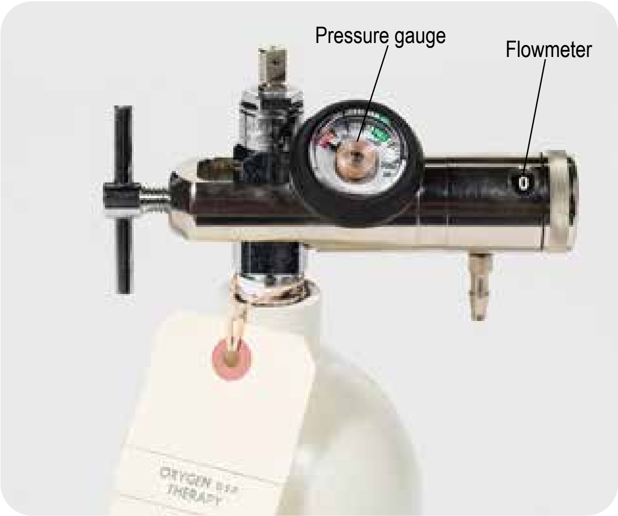

Figure 7-3 Medical post-type cylinder showing pressure gauge and flowmeter

Adapters: Modification of standard cylinders and regulators

It is important to remember that each type of oxygen regulator fits only one type of compressed gas cylinder. To connect different cylinders to a non-matching regulator, an appropriate adapter is required.

At times, in isolated areas, where large volumes of oxygen may be required, a commercial oxygen cylinder (249 cu. ft. size; K cylinder) may be used. A larger-type regulator and gauges with female 540 thread fit directly onto the male cylinder thread.

To fit the smaller, pin-indexed regulator and gauges onto the large 540-thread commercial cylinder, an adapter is required (see Figure 7-4 Assembly using the adapter).

To fit the larger 540-thread regulator and gauges onto pin-indexed medical cylinders, an adapter yoke is needed.

It is not necessary to use both types of adapters. Both types are effective and the choice is up to the company providing the first aid services.

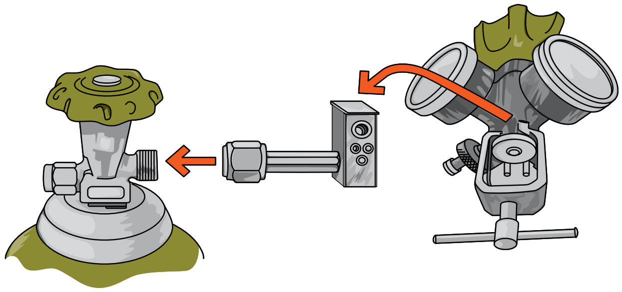

Figure 7-4 Assembly using the adapter

Oxygen delivery devices

Oxygen administration is a common intervention for patients with respiratory distress. Selecting the type of oxygen supply device should be based on the patient's oxygen requirements. The overall goal of oxygen therapy administration is to maintain adequate tissue oxygenation. Monitoring of oxygen-delivery effectiveness includes an assessment of blood oxygen saturation using a detecting device called a pulse oximeter (see Figure 7-5). non-rebreathing. When a patient is not breathing effectively, the attendant will provide supplemental oxygen using a pocket mask and positive pressure ventilation as outlined in Chapter 5, Airway Management. However, for a patient who will not tolerate assisted ventilations using a pocket mask, the attendant may switch to a face mask. Because the percentage of oxygen delivered is very inconsistent during respiratory distress, a nasal cannula is not recommended for these patients.

Figure 7-5 Pulse oximeter

Nasal cannula

A nasal cannula is an oxygen-delivery method consisting of a flexible clear plastic tube that connects to two smaller tubes at one end. The two smaller tubes are connected to each other on the other end to form a loop about the size of a basketball. At the end of the loop there are two 1 cm-long hollow prongs approximately 1.5 cm apart. The prongs are to be placed into the nostrils and the loop is placed over the patient's head. Each side of the loop is placed above the patient's ears (like a pair of glasses) and the loop is adjusted to fit comfortably around the patient's face and head (see Figure 7-6 Nasal cannula). The other end of the tube is connected to the outlet of a regulator, which is connected to an oxygen cylinder.

Oxygen passes through the tube, through the openings in the prongs, and into the nostrils as the patient breathes. The nasal cannula gives the patient the greatest freedom for moving around and talking. Flow rates of 1 to 5 L/min are appropriate when delivering oxygen using a nasal cannula. Oxygen concentrations at flow rates of 1 to 5 L/min vary between 24 and 44%. Flow rates above 5 L/min using a nasal cannula may result in discomfort to the patient, drying of the nasal passages and epistaxis (nosebleed). For patients who require a higher flow rate of oxygen, theattendant will utilize a face mask.

Figure 7-6 Nasal cannula

Simple face mask

The simple face mask is a formed clear plastic unit, with soft sides, that covers the mouth and nose and conforms to the patient's face. The mask connects to a flexible clear plastic tube which in turn connects to a regulator and oxygen cylinder. An elastic strap fastened to the mask holds it onto the patient's face. Perforations in the mask allow excess oxygen and the patient's exhaled carbon dioxide to escape into the surrounding atmosphere. To ensure the washout of exhaled carbon dioxide, a flow rate of greater than 6 L/min is needed. These masks are inexpensive and disposable and eliminate the need for cleaning and disinfection.

Simple face masks are used when moderate concentrations of supplemental oxygen are required. The mask is also indicated in patients with nasal irritation, or epistaxis and those who are strictly mouth breathers. A face mask can be obtrusive, uncomfortable, and may feel confining to the patient; it also muffles communication and impedes coughing. Oxygen concentrations will vary between 30% at a flow of 6 L/min and 60% at a flow of 10 L/min. You cannot provide 100% oxygen to a patient using a simple face mask, because the perforations in the mask allow atmospheric air to enter with inhalation.

Partial rebreathing mask

A partial rebreathing mask is similar to a simple face mask. It combines the face mask with a reservoir bag (see Figure 7-7 Partial rebreathing mask). It allows part of the patient's exhaled air to enter the reservoir bag, where it is enriched with oxygen from the supply system. Each time the patient inhales, the enriched mixture from the reservoir bag plus pure oxygen from the cylinder is supplied. The partial rebreathing mask can deliver increased concentrations of oxygen ranging from 40 to 60% when flow rates are between 6 L/min and 10 L/min, respectively. The partial rebreathing mask must be well fitted and the flow rate adjusted so that the reservoir bag does not deflate completely when the patient inhales. If the reservoir bag collapses during inspiration, the attendant should adjust the oxygen flow rate accordingly. When increased oxygen concentrations are required, the non-rebreathing mask is preferred.

Figure 7-7 Partial rebreathing mask

Non-rebreathing mask

As the name of this mask implies, the non-rebreathing (NRB) mask does not allow the patient to rebreathe any of their exhaled air. The main feature of this mask is a one-way valve placed between the mask and the reservoir bag. During expiration, carbon dioxide vents to the atmosphere. On inspiration, the patient receives high concentrations of oxygen from the reservoir bag and the cylinder. The one-way valve prevents exhaled air from entering the reservoir bag during exhalation.

The non-rebreathing mask is a very effective means of delivering high concentrations of oxygen to the spontaneously breathing patient. Concentrations approaching 90% can be provided as long as there are no leaks and the mask is properly fitted. The reservoir must not collapse during inspiration. If this happens, the attendant should adjust the flow rate accordingly.

Operating procedures

1. Setting up the equipment
   - Inspect the cylinder and regulator for dirt, dust, oil, and grease, especially around areas where high-pressure oxygen can come into contact with them. Inspect the regulator inlet for damage. Check the threads of the cylinder outlet and internal surfaces for damage, especially surfaces that come in contact with oxygen under high pressure.
   - Secure the cylinder in an upright position.
2. Installing the regulator
   - If the regulator has a yoke-type inlet connection:
     a. Remove the tape or strap that may be covering the cylinder outlet ensure the cylinder port is not pointing any anyone and crack the cylinder valve to blow any dirt or dust from the cylinder outlet.
     b. Make sure the gasket is in place on the regulator yoke inlet.
     c. Slip the yoke over the cylinder medical post and fit the yoke's index pins into the holes in the cylinder valve. Ensure the pins fit properly and are not forced into the connection holes.
     d. Turn the T-handle to hand tighten the regulator securely for a leak-proof seal (see Figure 7-8 Regulator attached to oxygen cylinder).
   - If the regulator has a nut-gland inlet connection:
     a. Remove the protective dust cover from the cylinder outlet ensure the cylinder port is not pointing any anyone and crack the cylinder valve to blow any dust or dirt from the cylinder outlet.
     b. Fit the regulator to the cylinder connection and thread the nut on the regulator connection to the cylinder-valve connection.
     c. With a suitable wrench, tighten the nut to secure the regulator and make a leak-proof seal.
   - If the regulator has a hand-tight inlet connection:
     a. Remove the dust cover from the cylinder outlet ensure the cylinder port is not pointing any anyone and "crack" the cylinder valve to blow any dirt or dust from the cylinder outlet.
     b. Thread the regulator-inlet connection onto the cylinder-valve connection.
     c. Tighten the regulator hand nut to secure it to the cylinder and make a leak-proof seal.
- Connecting oxygen-delivery equipment to the regulator's outlet connection
  - Connect the tubing from the face mask or nasal
  - cannula to the regulator-outlet nipple by hand (see Figure 7-8 Regulator attached to oxygen cylinder). If assisted ventilations are necessary, pull the tubing off the face mask and connect it to a pocket mask or bag-valve mask. Do not force these connections or leave them so loose that they fall off. To protect the patient from injury, the connection will blow apart whenever the oxygen flow exceeds 15 L/min.

Figure 7-8 Regulator attached to oxygen cylinder

- Opening the cylinder valve
  - Be sure the regulator flow rate has been shut off before opening the cylinder valve.
  - Open the cylinder valve counter-clockwise slowly and carefully until the regulator high-pressure gauge indicates pressure in the regulator. Wait for the regulator pressure to stabilize and then continue to open the cylinder valve one full turn.
  - To check the cylinder valve, inlet fitting, high-pressure gauge, or regulator seat, close the cylinder valve and observe the regulator's high-pressure gauge for 5 minutes. If there is any drop in the pressure-gauge reading, retighten the regulator-to-cylinder connection and repeat the test. Should there still be a drop in reading on the high-pressure gauge, the regulator must be removed from service.
- Adjusting regulator flow rate
  - Flow-gauge regulators — Turn the flow-adjusting knob on the regulator clockwise until the flow gauge reads the rate of oxygen flow desired
  - Flowmeter equipped regulator — Open the flow-adjusting valve until the centre of the ball is aligned with the line indicating the desired rate of flow.
- Closing the cylinder valve
  - Turn the regulator flow meter to zero, close the cylinder valve, then open the regulator and allow the gas pressure in the regulator to escape. The gas will cease to flow and the two needles on the regulator gauges will drop to zero if a flow gauge is being used. When a regulator equipped with a flowmeter is being used, the high-pressure gauge needle will fall to zero and the ball float will fall to the bottom of the flowmeter's flow scale when the gas ceases to flow.
  - The regulator valve should be closed after all the pressure has been relieved. Excessive force must not be used to close the regulator valve as this could result in damage.
- Removing the regulator from the cylinder
  - The regulator does not have to be removed unless the cylinder is nearly empty (i.e., 200 PSI or less).If there is any pressure showing on the high-pressure gauge, never attempt to remove the regulator from the cylinder.
  - When removing the regulator:
    a. Close the cylinder valve
    b. Open the regulator flow valve to bleed the residual pressure from the gauges
    c. Remove the regulator

Applying oxygen to the patient

Attach the tubing from the face mask to the oxygen regulator, open the flow valve, and initiate the flow of oxygen as previously explained. Turn the regulator flow valve clockwise to the desired flow and allow the oxygen to flow through the tubing for a few seconds before placing the mask on the patient's face. This is necessary to clear out any fluid or dust that may have lodged in the tubing.

Many patients have never seen oxygen equipment and it may cause some uneasiness or alarm. The attendant must reassure the patient about the use of oxygen and its benefits. As well, it sometimes reassures the patient if they can hold the mask to their own face with the oxygen flowing. Once the patient has become accustomed to the mask and oxygen flow, the elastic strap on the mask can be slipped over their head to hold the mask in position. The oxygen should always be flowing when applying the face mask to the patient.

Oxygen may have the following beneficial effects:

- improvement in skin colour and condition
- improvement in blood oxygen saturation
- quieter, easier breathing
- less pain for patient experiencing heart attack or angina
- less restlessness or an improved level of consciousness
- decrease in an abnormally rapid pulse rate

Pulse oximetry

A Health Canada–approved finger pulse oximeter may be applied to a patient by an attendant in the field (see Figure 7-5 Pulse oximeter). It is a small battery-operated electronic device that, depending on the patient's condition, can detect a pulse signal in an extremity such as a finger or toe, and can calculate the amount of oxygenated hemoglobin and the pulse rate. Red blood cells contain hemoglobin, an iron-containing protein. After oxygen is breathed into the lungs, it combines with the hemoglobin in red blood cells as they pass through the pulmonary capillaries. One molecule of hemoglobin can carry up to four molecules of oxygen, after which it is described as saturated with oxygen. SpO_2 stands for peripheral capillary oxygen saturation. It is an estimate of the amount of oxygen in the blood. If all the binding sites on the hemoglobin molecule are carrying oxygen, the hemoglobin is said to have a saturation of 100%. It may be expressed as SpO_2 100%. Most of the hemoglobin in blood combines with oxygen as it passes through the lungs. A healthy individual with normal lungs, breathing air at sea level, will have an arterial oxygen saturation above 95%. The attendant should use a pulse oximeter once all other critical interventions are complete. There are five important things that must happen in order to deliver enough oxygen to the tissues:

- Oxygenmust be breathed in (or inspired) from the air or oxygen-delivery system into the lungs.
- Oxygen must pass from the air spaces in the lung (alveoli) to the blood.
- The blood must contain enough hemoglobin to carry sufficient oxygen to the tissues.
- The heart must be able to pump enough blood to the tissues to meet the patient's oxygen requirements.
- The volume of blood in the circulatory system must be adequate to ensure oxygenated blood is distributed to all the tissues.

Several factors can interfere with the correct function of a pulse oximeter, including:

Light

Bright light (such as sunlight) directly on the probe may affect the reading. Shield the probe from direct light.

Shivering

Movement may make it difficult for the probe to pick up a signal.

Pulse volume

When the blood pressure is low, the pulse may be very weak and the oximeter may not be able to detect a signal.

Vasoconstriction

The oximeter may fail to detect a signal if the patient is very cold and peripherally vasoconstricted.

Carbon monoxide poisoning and/or toxic-smoke inhalation

Carbon monoxide binds very well to hemoglobin and displaces oxygen to form a bright red compound called carboxyhemoglobin, which may give a falsely high oxygen saturation reading. This is an issue in patients suffering from the effects of toxic-smoke inhalation from a fire.

Practical Application of the Pulse Oximeter

- Turn the pulse oximeter on.
- Select where it will go (usually a finger, toe, or ear). If used on a finger or toe, make sure the area is clean. Remove any nail polish.
- Position the probe, ensuring that it fits easily without being too loose or too tight.
- Allow several seconds for the pulse oximeter to detect the pulse and calculate the oxygen saturation.
- Look for the displayed pulse indicator that shows that the machine has detected a pulse. Without a
- pulse signal, any readings are meaningless.
- Once the unit has detected a good pulse, the oxygen saturation and pulse rate will be displayed.
- Like all machines, oximeters may occasionally give a false reading — if in doubt, rely on your judgment,
- rather than the machine.
- The function of the oximeter probe can be checked by placing it on your own finger.

If no signal is obtained on the oximeter after the probe has been placed on a finger, check the following:

- Is the probe working and correctly positioned?
- Is the finger or toe to which the oximeter was applied dirty, bloody or does it have nail polish on it? Try another location.
- Does the patient have poor perfusion due to shock
- or cardiac arrest?
- Check the temperature of the patient. If the patient or the limb to which the oximeter was applied is cold, gentle rubbing of the digit or earlobe may restore a signal.

Cleaning, care, and storage

When the attendant has finished using the equipment, the cylinder is shut off and the oxygen bled out of the gauges, so they read zero. If the gauges are left under pressure, they can be damaged. The cylinder, gauges, and regulator are checked for any damage that may have occurred during use. The amount of oxygen left in the cylinder is checked to ensure an adequate supply for any further emergency.

Oxygen face masks are generally considered to be a single-use disposable item.

When not in use, the cylinders should be stored in an upright or horizontal position and secured firmly in place. They are stored away from any corrosives and in a well-ventilated area that is not subject to high temperatures.

Part 5

Cardiovascular System

Part 5 **Cardiovascular System**

Anatomy and function of the circulatory system

The circulatory system is the transportation system of the body. It delivers a continuous supply of nutrients and oxygen to the cells and rids them of carbon dioxide and other waste products.

The circulatory or cardiovascular system is a complex arrangement of tubes called arteries, arterioles, capillaries, venules, and veins (see Figure 8-1 Circulatory system). Through these tubes, blood is circulated throughout the entire body under pressure from the pumping mechanism — the heart.

The circulatory system is made up of two separate systems. One provides circulation through the lungs (pulmonary circulation) and the other provides circulation through the rest of the body (systemic circulation).

Blood

Blood is a thick fluid that varies in colour from bright red (oxygenated) to a dark brownish-red (less oxygenated).

Blood components

Blood has two main components: blood cells and plasma.

Blood cells

Red cells give colour to the blood and carry oxygen. White cells help defend the body from infection. Platelets promote clotting, which is necessary to stop bleeding.

Plasma

Plasma carries the blood cells and transports nutrients to all tissues. It also transports waste products to the organs of excretion.

Blood Functions

Blood has three main functions:

- Transportation
- Combating infection
- Coagulation

Transportation

Oxygen from air in the lungs is absorbed by hemoglobin in the red blood cells and carried to all the tissues of the body. Carbon dioxide, a waste product of all metabolism, is carried by the plasma from the tissues to the lungs, where it is exhaled. The blood carries nutrients from the intestine to all body tissues, and waste products from the tissues to the liver and kidneys for excretion. Special secretions called hormones, which regulate growth and normal body functions, are transported by the blood from their organs of origin to their various destinations. The blood also transmits heat from the muscles to other parts of the body.

Combating infection

Certain white cells and proteins in the blood defend the body from disease-causing organisms.

Coagulation

Coagulation is the process of clot formation. When a blood vessel is damaged, cellular and protein elements in the blood start the clotting process to help to stop bleeding.

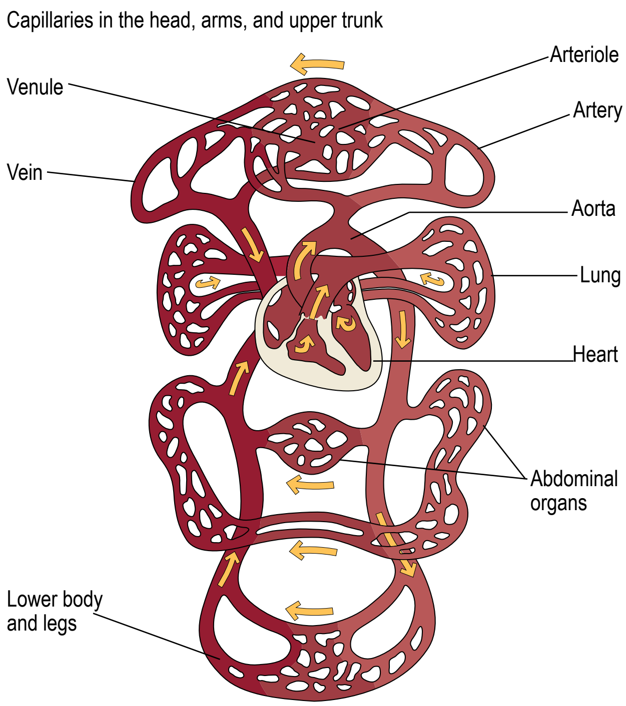

Figure 8-1 Circulatory system

Systemic circulation

Arteries

Arteries carry blood away from the pumping chambers of the heart (ventricles) to the organs and other parts of the body. The walls of arteries are thicker and more muscular than those of veins.

The aorta is the major artery leaving the left side of the heart. The aorta has many branches, supplying the head and neck, arms, thoracic, and abdominal organs. In the lower abdomen, it divides into the two main arteries that lead to the lower extremities (see Figure 8-2a Major arteries). Each artery divides into smaller and smaller branches (arterioles), finally forming the tiny thin-walled capillaries.

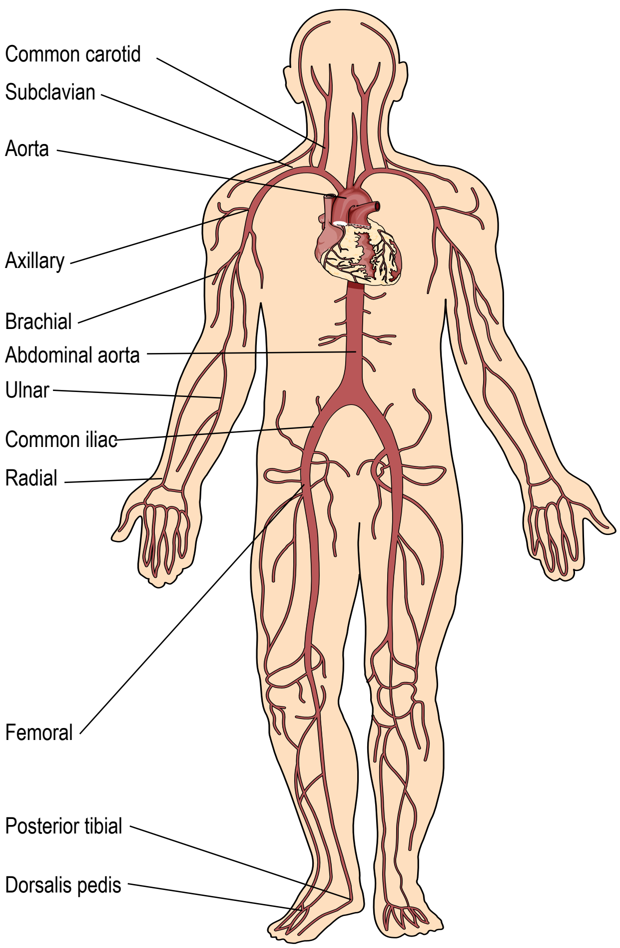

Figure 8-2a Major arteries

Veins

Blood from the capillary system returns to the heart through the veins. The smallest veins, called venules, are formed by the union of capillaries; these join to form larger veins. The veins of the entire body ultimately join to form two major veins, the superior vena cava and the inferior vena cava (see Figure 8-2b Major veins). Blood returning from the head, neck, shoulders, and upper extremities passes through the superior vena cava. Blood from the abdomen, pelvis, and lower extremities passes through the inferior vena cava. Both the superior and inferior vena cava empty into the right atrium (see Figure 8-4 Chambers of the heart). Veins are equipped with one-way valves that permit the blood to flow in only one direction. There is little pressure from the capillaries to force the blood back to the heart, so the return is aided by the activity of the skeletal muscles, particularly in the lower limbs.

As Figure 8-4 shows, blood from the right atrium is pumped into the right ventricle, which pumps it into the lungs through the pulmonary arteries.

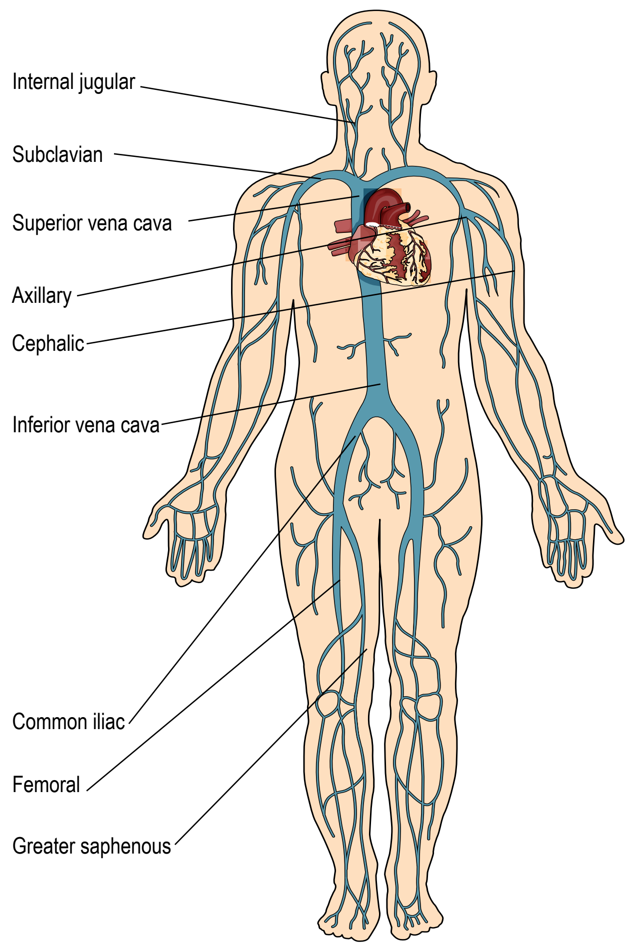

Figure 8-2b Major veins

Capillaries

The capillaries have the thinnest walls of any vessel as they are only one cell thick. The fine capillary walls readily allow exchanges between the blood and body cells. Oxygen, water, and other nutrients pass from the blood cells and plasma in the capillaries through their walls to the cells of the body tissues. At the same time, carbon dioxide and other waste products pass from the tissue cells to the blood to be carried away. Blood in the arteries is bright red because it is rich in oxygen. Blood in the veins is a dark brownish-red colour because it is low in oxygen. Capillaries connect at one end with the arterioles and at the other with venules. By the time the arteriolar blood reaches the capillaries, the blood pressure is very low, just enough to keep the blood flowing through the capillary beds.

Pulmonary circulation

Pulmonary arteries, the blood vessels from the right side of the heart, branch and re-branch, finally forming the pulmonary capillaries (see Figure 8-3 Pulmonary circulation). These capillaries form an extensive network over the surface of each alveolus (small air sac) in the lung tissue. Oxygen from the alveoli is absorbed by the blood, and carbon dioxide from the blood is released to the alveoli. The oxygenated blood from the lungs returns to the heart and enters the left atrium. It then passes into the left ventricle and is pumped into the systemic circulation again.

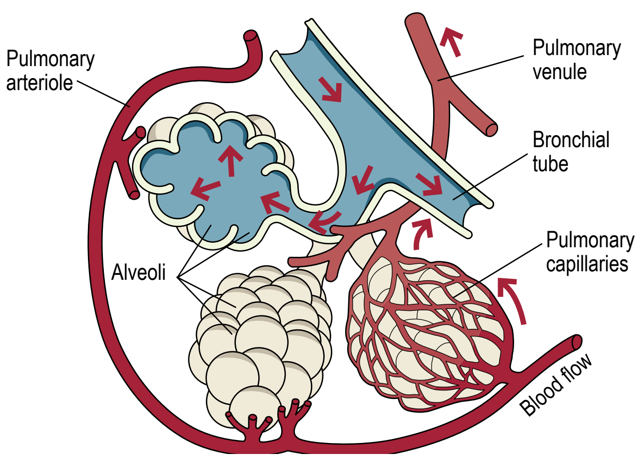

Figure 8-3 Pulmonary circulation

Heart

The heart is a hollow muscular organ, slightly bigger than a fist. It is located between the lungs in the centre and just to the left of the midline of the body.

A wall (septum) divides the heart down the middle. Each side of the heart is divided into an upper receiving chamber (atrium) and a lower expelling chamber (ventricle) (see Figure 8-4 Chambers of the heart). The heart is really a double pump, with both the right ventricle and left ventricle acting as the pumps. The right atrium receives the venous blood returning from the body tissues. The right atrium then delivers this venous blood to the right ventricle, which pumps it into the capillary network of the lungs. The capillaries are in close contact with the air sacs (alveoli) of the lungs. At this point, oxygen passes into the blood and carbon dioxide passes from the blood into the alveoli. This blood, now rich in oxygen, then flows from the lungs into the left atrium.

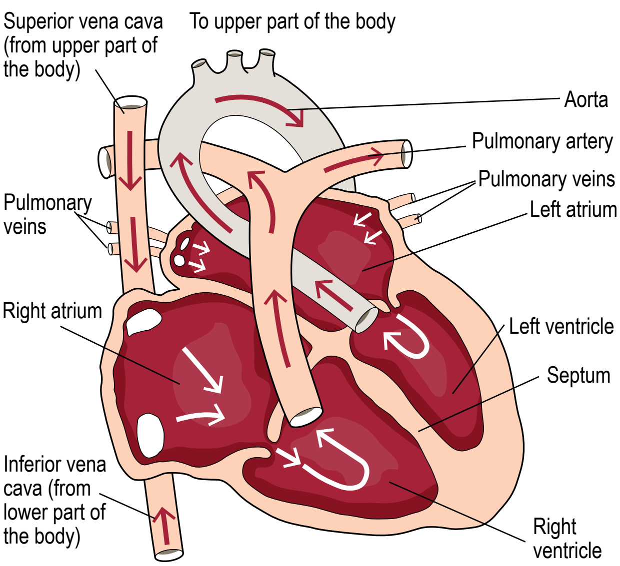

Figure 8-4 Chambers of the heart

The left atrium then delivers this oxygenated blood to the left ventricle. The left ventricle has much thicker muscular walls than the right ventricle, as it must pump the oxygenated blood to all parts of the body.

There are two openings in each heart chamber, guarded by one-way valves. The valves prevent back flow of blood and keep it moving through the arteries and veins in the proper direction (see Figure 8-5 Arteries and valves).

When a ventricle (lower chamber) contracts, the valve to the artery opens and the valve between the ventricle and the atrium (upper chamber) closes. Blood is forced from the ventricles into large arteries (on the right side into the pulmonary arteries and on the left side into the aorta). At the end of the contraction, the ventricles relax. The valves to the arteries close, the valves to the atria open, and blood flows from the atria to fill the ventricles. When the ventricles are stimulated, the pumping cycle repeats itself.

The rhythmical sequence of the pumping action of the different chambers of the heart is initiated by the heart's intrinsic pacemaker. Impulses generated in the pacemaker are carried over complex nerve pathways to all parts of the heart.

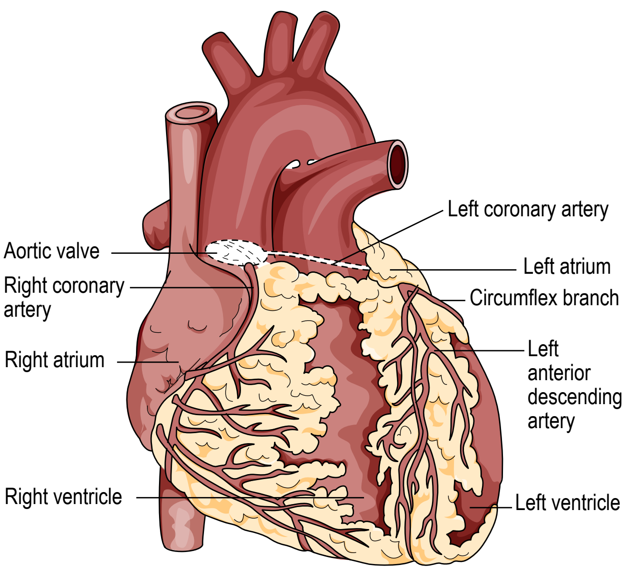

Figure 8-5 Arteries and valves

The contraction of the right and left ventricles is called systole; the relaxation of the heart while the ventricles fill with blood is called diastole. Therefore, within the arteries, there is a continuous variation between maximum pressure (systolic) and minimum pressure (diastolic).

Pulse and blood pressure

Pulse

The ventricles pump blood into the arteries about 60 to 80 times a minute. The force of ventricular contraction starts a wave of increased pressure that begins at the heart and travels along the arteries. This wave is the pulse. It can be felt in the arteries that are relatively close to the surface of the body, particularly if the vessel can be pressed against a bone.

- Carotid pulse — felt in the anterior neck adjacent and just lateral to the thyroid cartilage (Adam's apple).
- Radial pulse — felt at the wrist on the flexor surface at the base of the thumb.
- Femoral pulse — felt in the groin in the anterior crease between the leg and abdomen at a point approximately at the middle of the crease.
- Dorsalis pedis pulse — felt on the top of the foot.
- Posterior tibialis pulse — felt on the inside of the foot, behind the ankle.

Blood pressure

Blood pressure is the force exerted by the blood against the walls of the arteries as it passes through them. The repeated ejection of blood from the left ventricle of the heart into the aorta is transmitted through the arteries as a series of pressure waves. This serves to keep the blood moving through the body. The arterial blood pressure can be measured with a blood pressure cuff.

Two measurements are taken:

- Systolic pressure: the maximum pressure occurring at the peak of the left ventricular contraction.
- Diastolic pressure: the minimum pressure during relaxation of the left ventricle.

Several factors control arterial blood pressure — the blood volume itself, the state of the arteries and arterioles (dilated or constricted), and the capacity of the heart muscle to contract normally.

The pressure of the blood in veins is much less than that of the blood in arteries. Two factors control the pressure of the venous blood: blood volume and the capacity of the veins. The average adult body has approximately 6 L (10 pt.) of blood. However, the capacity of all the body's blood vessels is much larger than 6 L (10 pt.). When a person is healthy, the difference between the blood volume and the capacity of the blood vessels is constantly adjusted by a complex autoregulation system. This system matches the fluctuating blood needs of the various organs and other parts of the body. Thus, when the body is exercising, more blood flow will be directed to the muscles from the organs that do not have as high a metabolic need — e.g., the gastrointestinal tract.

Conversely, when an individual eats a meal, more blood will be directed to the gastrointestinal tract and away from the muscles.

The change in the diameter of the arteries and veins is governed by muscles in their walls. These muscles can contract or relax in response to changes in blood volume, heat, cold, injury, or an infection. These muscles do not act as pumps, but their contraction or relaxation changes the diameter of the vessels. If the muscles of the arteries and veins contract, the diameter of the vessels decreases and the system holds less fluid. But if these muscles relax, then the vessels dilate and the system can hold a larger volume of blood.

Loss of normal blood pressure is one indication that the blood cannot circulate efficiently to the body's organs. There may be many reasons for the loss of blood pressure. The end result in each case is the same: body organs are no longer adequately perfused. This means that the cells in these organs are not receiving sufficient oxygen or nutrients and that waste products of cell function — carbon dioxide and acids — are not being removed. Without adequate perfusion, the cells will die. This state of inadequate perfusion is called shock.

Shock

Circulatory shock is an emergency that, if not recognized and treated early, may cause the death of the patient. Early recognition, treatment, and early rapid transport are essential.

Definition of shock

Shock is the state of inadequate perfusion of the cells. The ultimate result of inadequate perfusion for each cell will be that it has too little oxygen and too much acid. This will cause a series of cascading changes:

1. Cell function stops
2. Cells eventually die
3. When enough cells die, the tissue dies
4. When a significant amount of tissue dies, the organs will die
5. When organs stop functioning, the body dies

The aim is to interrupt the series of changes before cell death begins. The fundamental problem in shock, regardless of cause, is a marked reduction in blood flow through the tissues. Initially, that results in cellular hypoxia (low oxygen) and ultimately, it results in acidosis (accumulation of acids). The body tries to compensate and control the metabolic consequences of impaired tissue perfusion. After a certain point the body can no longer compensate, all control is lost, and shock becomes irreversible. The primary aim in the treatment of shock is to increase tissue perfusion.

Unless this is done quickly, the patient will die. There may be only a short time between the onset of shock and the point when it becomes irreversible. It is essential that the cause of the problem be identified promptly and the patient transported to hospital as soon as possible.

Recognizing shock in the early stages and promptly transporting the patient to hospital is one of the most important functions of the attendant. Any patient in shock is in the rapid transport category.

Since most attendants are unable to use intravenous fluids or advanced airway techniques to treat shock, they must be even more alert to the early evidence of shock.

Cellular function

Shock is a lack of tissue perfusion causing a disorder of the tissue's cells. The cell is the smallest complete unit of life. Cells with similar functions are grouped together into tissues. Tissues with similar functions are then grouped together into individual organs.

The heart and brain, which are the vital organs, are much more important for the moment-to-moment existence of the body than others. Should they fail suddenly, the body will die very quickly.

The cells of tissues and organs have specific functions. To function properly, each cell requires energy and a system of waste removal. The cells use oxygen and sugar to make energy. When a cell gets little or no oxygen, it uses an alternative method to make energy; this method is very inefficient and generates a large amount of waste (mostly acids).

Oxygen is important to body cells because the lack of oxygen will result in:

- Loss of energy production
- Accumulation of harmful waste products

Perfusion

Perfusion is the flow of blood to and from the body cells. As blood flows to the cells, it carries life-giving oxygen and nutrients. As the blood flows by the cells, it gives up oxygen and nutrients in exchange for carbon dioxide, acid, and other wastes. The blood then carries these wastes away from the cell.

Proper cell function requires adequate perfusion. The body achieves this with the circulatory system:

- Blood (fluid transport of fuels and wastes)
- Heart (pump)
- Blood vessels (the system of arteries, veins, and capillaries that transport blood to and from all the individual cells of the body)

To ensure that the cells receive an adequate supply of oxygen, the body must also have an intact functioning respiratory system.

Causes of shock

Among injured patients, shock is almost always caused by blood loss (hypovolemic shock). It is often made worse by any condition impairing adequate air exchange (e.g., chest injury). There are three main causes of inadequate perfusion:

1. The volume of blood in circulation becomes inadequate, resulting in hypovolemic shock:
   - Blood loss — bleeding
   - Fluid loss — burns, vomiting, diarrhea
2. The heart is damaged and fails to function properly:
   - Cardiogenic shock — myocardial infarction (heart attack)
3. The blood vessels dilate excessively. In this situation, the normal volume of blood is insufficient to fill the dilated blood vessels to capacity. This leads to inadequate tissue perfusion:
   - Anaphylactic shock — severe allergic reaction
   - Septic shock — severe bacterial infection
   - Neurogenic shock (spinal) — injury to the nervous system

Any combination of problems with the heart, blood volume, or blood vessels may cause inadequate perfusion of the cells, leading to the state of shock. For example, an injured worker with internal bleeding may have hypovolemic shock complicated by a heart attack.

Any condition that impairs adequate air exchange and oxygen transfer in the lungs, such as airway obstruction, pneumothorax, or flail chest, will worsen the patient's shock state.

The body's response to shock

The autonomic nervous system regulates the circulatory system to provide adequate perfusion. The tissues of the body require much more blood when they are active than during rest. Without the autonomic nervous system regulating the flow of blood, it would be necessary to continuously supply all of the tissues at the maximum rate. This would take much more blood and a much larger heart. The autonomic nervous system causes the arterioles leading to tissues at rest to constrict and those supplying active tissues to dilate. Blood is thus distributed according to need.

The blood pressure depends upon the:

- the resistance to flow of the circulating blood by the arterioles (arteriolar resistance)
- the volume of blood pumped by the heart into the systemic circulation (cardiac output)

Arteriolar resistance refers to back pressure exerted by the arterioles on the blood flow. The concept of arteriolar resistance (also called peripheral resistance) is best illustrated by the example of the adjustable nozzle at the end of a hose. Without a nozzle, a fully open tap may not produce much pressure. With a suitably adjusted nozzle, even a small flow from a tap may produce pressure that propels the stream of water forcefully.

The arterioles' muscular walls are constantly receiving nerve impulses from the autonomic nervous system. This keeps them in a state of partial contraction. Just as the pressure in the hose depends on the amount of water flowing from the tap and the adjustment of the nozzle, so the blood pressure depends upon the cardiac output and the degree of constriction of the arterioles in the arteriolar system. The autonomic nervous system matches cardiac output to peripheral resistance to maintain the blood pressure and ensure adequate perfusion of the cells as their needs change.

Any reduction in cardiac output will tend to cause a reduction in systolic pressure. This change in pressure is detected by special pressure receptors. The receptors trigger the autonomic nervous system, which attempts to restore cardiac output and blood pressure to normal. The two key hormones in this system are adrenalin and noradrenalin.

Adrenalin and noradrenalin cause:

- An increase in heart rate and a more forceful heart contraction. These actions will increase cardiac output and increase blood pressure.
- Constriction of the arterioles (vasoconstriction) in non-vital organs (e.g., skin, kidneys, liver, gut), which decreases the blood flow to these organs. This action redistributes blood flow to the vital organs (the brain and heart).
- Sweating (diaphoresis). This can increase fluid loss and aggravate shock. The attendant must watch for this effect as it is a key sign in the detection of shock.

The body has a great ability to compensate for bleeding by using the same mechanisms that operate in normal situations. The body compensates for the decreased circulating blood volume by releasing large amounts of adrenalin and noradrenalin. Consequently, the arterioles in non-vital organs constrict and most of the remaining blood volume is redistributed to the vital organs (the heart and brain).

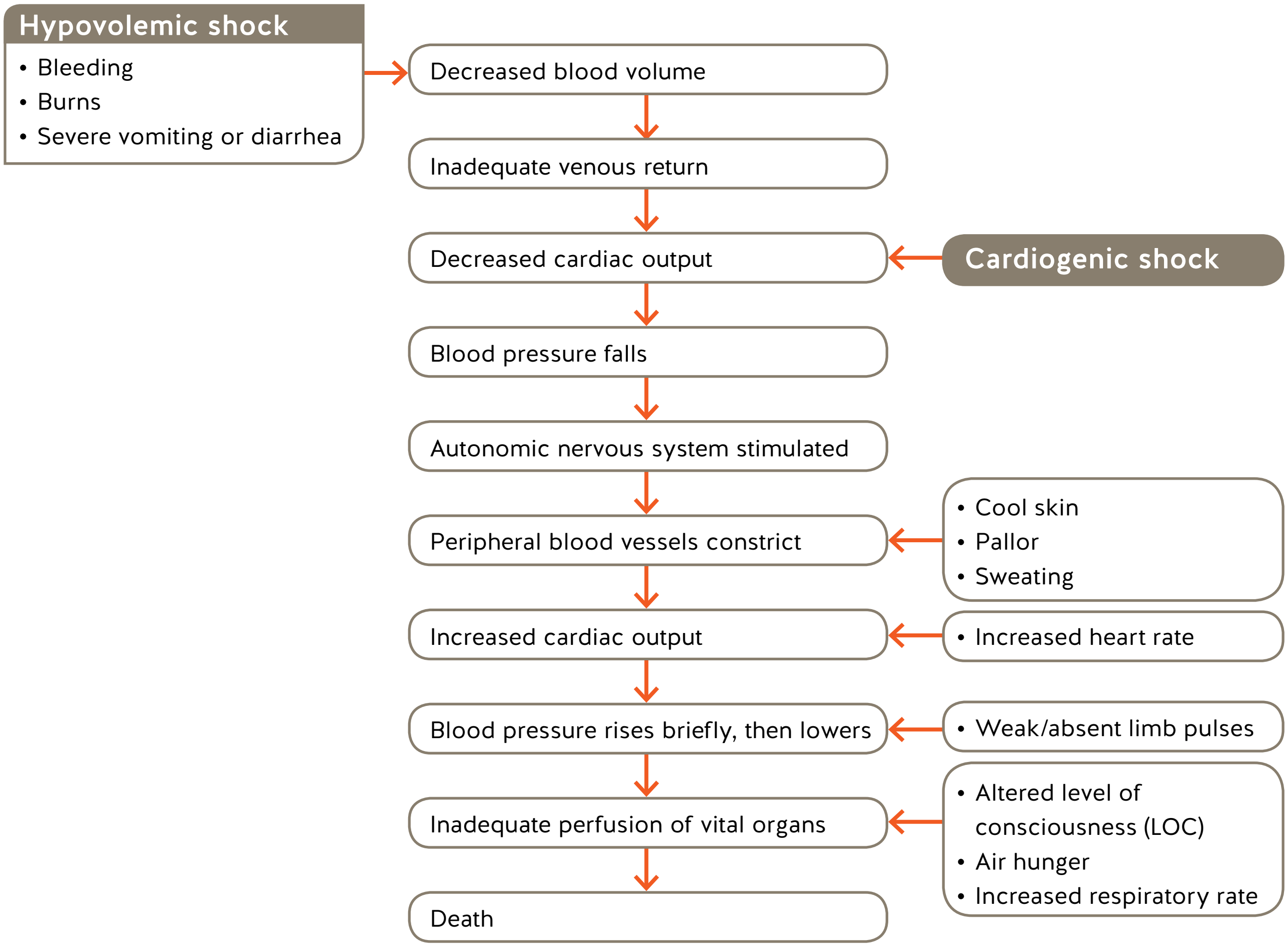

Figure 9-1 Body's response to hypovolemic and cardiogenic shock

This vasoconstrictive response attempts to maintain blood pressure and perfusion of the vital organs until lost blood can be replaced. However, it deprives the other tissues of blood they need to maintain their metabolic activity.

If blood volume loss continues or if shock is not reversed by early medical treatment, the perfusion of body organs will eventually become insufficient to maintain normal cell function. As the condition worsens, cells die, with subsequent tissue and organ dysfunction. As the shock state progresses, the cardiac output cannot be maintained, blood pressure falls, and death becomes inevitable (see Figure 9-1 Body's response to hypovolemic and cardiogenic shock).

Patients with early signs of shock will demonstrate increased autonomic nervous system activity, especially the effects of increased adrenalin and noradrenalin. The early signs of shock are coolness of the skin, pallor, and sweating.

Types of shock

This section discusses the following types of shock:

- Hypovolemic shock
- Cardiogenic shock
- Anaphylactic shock
- Bacteremic or septic shock
- Neurogenic shock

Hypovolemic Shock

Excessive blood loss, as from injury, leads to inadequate circulating blood volume. As a result of the decrease in circulatory blood volume, there is inadequate perfusion and a state of shock ensues.

A similar effect may occur because of fluid loss, either through the gastrointestinal tract, such as with profound diarrhea or vomiting, or from the body surfaces, as when a patient has extensive burns.

Signs and symptoms of hypovolemic shock

Many of the signs and symptoms of shock are caused by the body's vasoconstrictive response. The following signs and symptoms are listed in the order in which they tend to occur as the shock state progresses.

Cool skin

Often an early sign of shock. It occurs when warm blood is rerouted from the skin as a consequence of the constriction of blood vessels (vasoconstriction).

Pallor

With vasoconstriction, blood is no longer flowing to the surface of the body; consequently, the skin loses its normal colour.

Sweating

This develops as a direct effect on the sweat glands because of the autonomic nervous system's response to shock. It suggests that the shock state is more advanced. The skin may be clammy or wet.

Increased heart rate (usually greater than 100 beats per minute)

Thisreflects the heart's response to adrenalin and noradrenalin. A more rapid heart rate usually indicates a more severe state of shock.

Low blood pressure (hypotension)

This is defined as a systolic pressure reading of less than 100 mm Hg measured on a blood pressure cuff. Alternatively, the absence of the radial pulses indicates a blood pressure reading of less than 90 mm Hg. Weak or absent pulses indicate hypotension, which is a late sign of shock and indicates a massive loss of blood volume with the body unable to compensate. Regardless of the cause, the patient is in very urgent need of medical attention.

Alteration of behaviour and/or level of consciousness (LOC)

In its early stages, shock is often associated with anxiety, restlessness, or combativeness. This is due in part to the release of adrenalin. As shock increases and hypoxia becomes more pronounced, the patient may become very agitated and restless. The agitation may be more pronounced when there is a head injury. As the perfusion of the brain decreases, the level of consciousness decreases.

Tachypnea (an increased respiratory rate of between 20 and 30 breaths per minute)

Usually a patient in shock breathes more rapidly and can gasp for breath with "air hunger" as a consequence of hypoxia and acidosis. This sign may also be present with associated chest injuries. The attendant must be very concerned about an associated chest injury if the respiratory rate is greater than 30 breaths per minute.

Thirst

Owing to a reduced blood volume, patients in shock often complain of intense thirst. The patient should be given nothing by mouth in case surgical treatment is required.

Patients with hypovolemic shock who must receive special consideration

Athletes

The trained athlete has a well-conditioned heart muscle and cardiovascular system. The normal resting heart rate may be below 50 beats per minute. As a consequence, despite significant blood loss, the athlete may adequately compensate for shock. Therefore, an athlete may not exhibit an increased heart rate or diminished blood pressure until either a large volume of blood has been lost or the shock state has become advanced.

Pregnant women

During pregnancy, a woman will have up to a 20% increase in blood volume. Consequently, following trauma, she may not initially exhibit signs of shock. The fetus, however, will experience profound shock as the maternal vasoconstrictive response to shock shunts the blood from the fetus to the maternal vital organs. Any woman pregnant longer than 20 weeks who has received trauma, even if insignificant — e.g., a fall on stairs — should be referred to a physician for assessment. Any pregnant woman who has received significant trauma — e.g., a limb fracture, or chest or abdominal trauma — or exhibits any signs of shock is in the Rapid Transport Category.

Cardiac patients

There are two major complications with cardiac patients:

- Cardiac patients are at a higher risk of developing shock from trauma because of their weaker hearts. Furthermore, they may also develop chest pain and/or shortness of breath.
- Patients on heart medication may not exhibit the early signs of shock because these medications may dampen the body's normal vasoconstrictive response.

Any cardiac patient who has received significant trauma must be watched closely and put into the rapid transport category if the attendant finds signs of shock.

Cardiogenic shock

In cardiogenic shock, the heart muscle does not pump enough blood to peripheral tissues. The most common cause of cardiogenic shock is acute myocardial infarction (MI, or heart attack). The strength and force of the left ventricular contraction is reduced because of extensive structural damage to the ventricle wall. Other conditions that can cause cardiogenic shock include congestive heart failure and chest trauma — e.g., contusion of the heart, pericardial tamponade, or tension pneumothorax.

The signs and symptoms of cardiogenic shock are essentially the same as seen with hypovolemic shock.

Anaphylactic shock

This condition is caused by a severe allergic reaction. It may be caused by the injection, ingestion, or inhalation of a foreign protein substance into a person sensitized to it. The allergic reaction may lead to a loss of the normal tone of the blood vessels. The shock state is caused by abnormal systemic dilatation of the blood vessels (vasodilation), causing the blood pressure to drop and resulting in body-wide inadequate perfusion of the cells.

Agents that may commonly cause anaphylactic shock include insect stings, antibiotics, seafood, nuts, and blood or other transfusions. Some individuals susceptible to severe allergic reactions wear medical alert bracelets or necklaces and may also carry an epinepherine auto-injector (refer to page 289).

This form of shock is distinguished by its rapid onset. One cannot predict how severe the allergic reaction is likely to be in susceptible individuals. Severe reactions may occur immediately or be delayed for half an hour or more. There may be constriction of the upper airway and the bronchioles, with impaired breathing. The impairment of breathing and of proper circulation prevents the normal supply of oxygen from reaching the cells. Patients undergoing a suspected anaphylactic reaction are in the rapid transport category.

Signs and symptoms of anaphylactic shock

Patients experiencing anaphylactic shock may be identified by any of the following signs and symptoms:

- A medical alert bracelet or necklace indicating an allergy
- Generalized itching
- Numbness and tingling, especially about the face and mouth
- Blotchy areas of raised reddish-pink swelling of the skin that are very itchy (hives)
- Swelling of the tongue and face
- Tightness in the throat or upper airway
- Breathing difficulty, possibly with wheezing
- A tight discomfort across the chest
- General weakness, restlessness, dizziness, or anxiety
- Abdominal cramps, diarrhea, or vomiting
- A rapid, weak pulse

Bacteremic or septic shock

Profound circulatory collapse may result when certain bacteria invade the bloodstream. It is believed that these bacteria produce toxins. They ultimately affect the blood vessel walls, causing generalized vasodilatation and, ultimately, diminished tissue perfusion. This type of shock is seen most often in a hospital setting. It also has been recognized in women as toxic shock syndrome associated with the use of tampons.

Signs and symptoms of septic shock

- Confusion is often the earliest sign due in part to bacterial toxins
- High fever with warm, flushed skin that later becomes cool and pale
- Increased pulse rate
- Increased respiration

Neurogenic shock (spinal shock)

In neurogenic shock, the blood vessels to the lower extremities, abdomen, trunk, and sometimes part of the upper extremities suffer impairment of their autonomic nerve control. As a consequence, the blood vessels dilate markedly, increasing their capacity. The patient's blood volume becomes pooled in these dilated blood vessels, resulting in a reduced return to the heart. Although there is no actual blood loss, the patient's normal blood volume is inadequate to maintain perfusion of the cells.

Neurogenic shock occurs only in the presence of a spinal-cord injury with complete paralysis. Neurogenic shock does not occur with spinal fractures alone.

Spinal shock is a rare cause of shock in trauma patients, even in those who have suffered spinal cord injuries. Trauma patients with shock are much more likely to be in hypovolemic shock caused by internal injuries. All injured patients found in shock, regardless of the presence of spinal injuries, must be treated as though their shock is caused by acute blood loss.

Signs and symptoms of neurogenic shock

- Paralysis and numbness of the lower extremities and various portions of the trunk
- Possible impaired breathing as a consequence of paralysis of the chest muscles (see page 145, Special Precautions for Patients with Spinal-Cord Injury)
- May have warm and dry skin in the extremities
- May have a lack of a radial pulse

General principles of shock management

The evaluation and management of the injured worker in shock follows the priority action approach outlined on page 18.

1. Conduct the scene assessment. Activate the workplace emergency response procedures as required.
2. Assess the level of consciousness. Attempt to communicate with the patient. If the patient is unresponsive, open the airway and check for breathing and a carotid pulse for 5-10 seconds — if the patient is hypothermic, up to 30 seconds. If the patient is not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest. In this situation CPR is initiated according to Part 5, Chapter 13.
3. When the patient is not in cardiac arrest, ensure an open airway (with C-spine control if the mechanism of injury suggests spinal trauma). If there is no concern for cervical injury, the patient may be positioned for comfort but should be maintained in a horizontal position.
4. Assess for signs of respiratory distress or signs of oxygen deficiency — e.g., dyspnea, gasping, or cyanosis. Assist ventilation if needed according to the criteria on page 60. A pocket mask is the preferred method. Ventilate the patient once every 5 seconds timed with the patient's inhalation, if possible. Train a helper to take over the assisted ventilation. If the patient is unresponsive to verbal stimuli, insert an oral airway. Administer oxygen at 10 L/min connected to the pocket mask.
5. Assess for adequate breathing — e.g., inadequate and/or asymmetrical chest movements, the use of accessory muscles of respiration, overexpanded chest, open wounds, bruising, abrasions, or paradoxical movement. An open airway does not ensure adequate ventilation and, if necessary, intervene as in step 5 above.
6. Assess the adequacy of the patient's respirations and, is not effective, intervene as in step 4 above.
7. If the radial pulse and the skin for signs of shock. The patient is in shock if:
   - The skin is cool and pale with a history of major
   - external bleeding or internal injury, or the skin is cool, pale, and clammy, or
   - The radial pulses are absent.
8. Apply oxygen at 10 L/min by face mask.
9. Control life-threatening bleeding. (Bleeding interventions may have been started earlier). Complete the rapid body survey. Expose the patient's chest during the rapid body survey if there was a history of trauma to the chest.
10. If the patient is suffering from anaphylactic shock and has an epinepherine auto-injector, assist them in using it (refer to page 289).
11. All patients in shock or suspected of developing shock are in the rapid transport category. Following the primary survey and initial management of life-threatening injuries, the patient must be transported rapidly to the nearest hospital.
12. Reassess the ABCs every 5 minutes.
13. Avoid all unnecessary movement or rough handling because such action will aggravate the shock state. Give nothing by mouth.
14. Protect the patient from the elements and keep them comfortably warm. Do not apply external heat sources — e.g., heating pads or hot-water bottles — which will cause vasodilatation in the skin and worsen the shock state.
15. Give nothing by mouth.
16. Conduct a secondary survey during, or while awaiting, transport.
17. Monitor the patient's ABCs every 5 minutes and vital signs every 10 minutes to determine if there is deterioration.

Bleeding and its management

This chapter introduces the attendant to the characteristics of bleeding and provides guidance on bleeding recognition and management.

Hemorrhage characteristics

Bleeding (hemorrhage) is the loss of blood from arteries, veins, or capillaries. The rate at which blood is lost is significant. The average adult may comfortably lose 500 mL (approximately 1 pt.) of blood over 15 to 20 minutes — e.g., as with a blood donation. During this 15 to 20 minutes, the body adapts to its loss quite well. If larger amounts are lost or this amount is lost more quickly, the patient may go into shock. If massive bleeding is not controlled, the patient may die. Consequently, brisk hemorrhage should be identified and controlled in the primary survey. Rapid external blood loss is usually manageable by direct pressure on the wound. Bleeding may be external or internal.

Internal

The skin is not broken and bleeding may not be visible. Hidden bleeding into the thoracic or abdominal cavities or into muscle surrounding a fracture can account for a large amount of blood loss.

External

There is a break in the skin and blood escapes to the outside.

No matter whether bleeding is internal or external, it can be serious as it may cause shock.

Descriptions of bleeding are usually divided into arterial, venous, and capillary, according to which vessel is mostly involved. Arterial bleeding is often the most rapid and significant bleeding, and may be difficult-to-control. Capillary and venous blood loss can also be significant but is usually easier to control with direct pressure. All wounds will include some capillary bleeding and most arterial bleeding will involve a corresponding vein.

Arterial bleeding

Blood from an artery spurts or pulses out and is usually bright red (see Figure 10-1 Hemorrhage characteristics). It may be very brisk if a large vessel is involved.

Venous bleeding

Blood from a vein generally comes in a steady flow and its colour is much darker than arterial blood (see Figure 10-1 Hemorrhage characteristics). Venous bleeding may also be very brisk if a large vessel is involved.

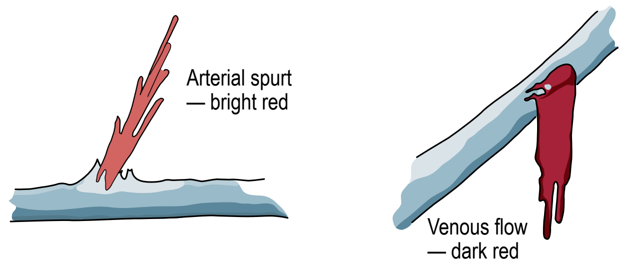

Figure 10-1 Hemorrhage characteristics

Capillary bleeding

Bleeding from capillaries is a continuous, steady ooze.

The body's natural response to bleeding

The body naturally attempts to stop bleeding (achieve hemostasis) in two ways:

- Retraction of blood vessels — The elastic muscle fibres in the walls of the damaged blood vessels cause them to pull back into the tissue, thus constricting them at the cut ends. This reduces bleeding.
- Clotting — Special elements in the blood form a clot, which seals the injured portion of the vessel and stops the bleeding.

In some cases, the damage to blood vessels is so severe that clots cannot form, nor can the damaged blood vessels constrict effectively. Blood loss may sometimes be so fast that if the attendant waits for the body's natural response, the patient may go into shock or bleed to death. For clotting to take place, the flow of blood from the wound must be slowed or stopped for at least a few minutes.

Internal bleeding

Internal bleeding is usually associated with injury to the internal organs resulting in hemorrhage into one of the body cavities — e.g., the thorax or abdomen. It can also occur with fractures of the pelvis or a femur. Because the bleeding is not directly visible, the attendant must rely on the mechanism of injury and the findings during the assessments to suspect and diagnose internal bleeding.

Patients with internal bleeding are in the rapid transport category.

In some cases, the onset of signs and symptoms of internal bleeding may be delayed. The attendant must therefore use the secondary survey and continual re-evaluations, watching for signs and symptoms of shock to diagnose internal bleeding.

Internal bleeding may produce shock. Internal bleeding must be suspected when a patient's condition deteriorates following an injury.

Signs and symptoms of internal bleeding

- The skin becomes cool or cold, pale, and clammy
- The pulse becomes weak and rapid
- The patient may have air hunger or shortness of breath
- The patient may faint or become dizzy
- The patient may be thirsty, anxious, and restless
- The patient may be nauseous and may vomit

External bleeding

Bleeding from skin lacerations is an example of external bleeding. Ordinarily, for most minor wounds, bleeding stops on its own within minutes, as the body has its own defence system against blood loss. When larger blood vessels are involved, however, it is often necessary for the attendant to control bleeding (see Figure 10-2 Pressure applied to wound).

The attendant must follow the priority action approach.

1. Airway open, with C-spine control if necessary.
2. Breathing adequate.
3. Circulation assessed and bleeding controlled.

Figure 10-2 Pressure applied to wound

The three Ps of hemorrhage control

In the control of external hemorrhage, the attendant must remember three basic elements:

1 Pressure

Pressure applied directly on the wound

2 Patient "position-at-rest"

The patient should be at rest, lying down. Putting the patient at rest will lessen their anxiety and help the bleeding to slow down.

3 Part "prevent movement"

Preventing unnecessary movement of a bleeding part may help to slow down the flow of blood. If moving the extremity causes extreme pain or aggravates the injury, do not elevate the limb.

Pressure

Pressure applied directly on the wound will control nearly all types of bleeding. Pressure may first be applied with a gloved hand. If available, soft, clean, and absorbent material such as a dressing, shirt, towel, or handkerchief may be used. In this situation, obviously a sterile pressure dressing or gauze pads are preferred. Once the sterile dressing is in place, pressure on the wound is maintained by a bandage that secures the dressing. To minimize further damage, the injured limb should be supported while the dressings and bandages are being applied. The entire sterile dressing should be covered above and below the wound by the bandage, tightly secured. If the dressing becomes blood-soaked, the attendant should apply additional dressings over the initial dressings and continue to apply direct pressure over it.

On occasion, with persistent venous or capillary bleeding through the dressing, the attendant may feel it necessary to remove the dressing once, to visually ensure that pressure is being applied directly on the wound. If bleeding persists despite additional dressings and bandages, the attendant should apply firm pressure over the wound with a gloved hand for 5 minutes. Arterial wounds that are difficult-to-control may require a tourniquet for bleeding control (see Figure 10-3 Tourniquet used for difficult-to-control hemorrhage).

Scalp wounds are notorious for persistent bleeding, owing to the difficulty of applying direct pressure with dressings, and also due to the fact that the scalp vessels do not vasoconstrict as readily as vessels in other locations.

Figure 10-3 Tourniquet used for difficult-to-control hemorrhage

Tourniquets

Tourniquets are rarely needed. If a patient is bleeding severely enough to require a tourniquet, the patient is in the rapid transport category.

A tourniquet is a constricting or compressing bandage used to control severe bleeding from an extremity and can be used to control hemorrhage if:

- All other methods fail, or
- Another life-threatening priority demands the attendant's attention or if you are unable to get to the injury, e.g., an arm or leg is trapped in machinery or equipment, and you cannot get to the bleeding site to apply direct pressure (see Figure 10-4 Application of a tourniquet at a long bone).

Figure 10-4 Application of a tourniquet at a long bone

The tourniquet is applied proximal to the wound and on the upper arm or the thigh where the artery can be compressed against a single long bone (see Figure 10-3 Tourniquet used for difficult-to-control hemorrhage). If there has been an amputation, it should be as close to the end of the stump as possible.

The best type of tourniquet to use is a commercial tourniquet that is designed for tactical applications such as a Combat Application Tourniquet (CAT), which has been studied and recommended for use in a first aid setting. An Esmarch bandage is a reasonable alternative if a commercial device is not available. An Esmarch is a rubber bandage, approximately 7.5 cm x 90 cm (3 in. x 30 in.). Apply the bandage with even pressure on each wrap and provide a greater degree of pressure on each succeeding wrap. The bandage should be applied so that there is a 2 mm to 5 mm (¼ in.) margin of the preceding wrap visible. If an Esmarch bandage is not available, the best substitute is a 7.5 cm (3 in.) tensor bandage.

Certain precautions must be observed when using tourniquets:

- Do not use a tourniquet unless other means of hemorrhage control are ineffective or another life-threatening priority demands the attendant's attention.
- If at all possible, avoid using material such as belts, rope, or wire, which can cut into tissue.
- Ensure that the tourniquet is applied with sufficient pressure. A loose application will increase venous blood flow from wounds beyond the tourniquet.

- Tourniquets, once applied, must never be released by the attendant or covered by bandages.
- The patient must be clearly marked as having a tourniquet and the time it was applied. Fix a large tag to the patient's body, preferably not to the clothes but to a limb. An alternate method would be to write "tourniquet" in ink on the patient's skin in large letters at the time it was applied.
- Patients requiring tourniquets are in the rapid transport category. The attendant should not waste time applying local splinting techniques.

Immobilization for hemorrhage control

Bleeding from an injured extremity often occurs because muscles are lacerated by the sharp ends of broken bones or because vessels lying in the fractured bone continue to bleed.

When there is a break in the tissue, whether it is soft tissue or bone, some of its ability to support itself is lost. Until the injured part is effectively immobilized, any movement may cause further damage and continued bleeding. For this reason, immobilization of a fractured or lacerated extremity may help to maintain the hemorrhage control.

General principles of management of external hemorrhage

The evaluation and management of the injured worker with hemorrhage follows the priority action approach outlined on page 18.

1. Conduct the scene assessment. Activate the workplace emergency response procedures as required.
2. Assess the level of consciousness. Attempt to communicate with the patient. If the patient is unresponsive, open the airway and check for breathing and a carotid pulse for 5-10 seconds — if the patient is hypothermic, up to 30 seconds. If the patient is not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest. In this situation, CPR is initiated according to Part 5, Chapter 13. If possible, CPR should commence with control of the hemorrhage at the same time.
3. When the patient is not in cardiac arrest and if any of the following are present on approach, position the patient supine (with C-spine control if the mechanism of injury suggests spinal trauma):
   - The patient has signs of shock
   - The bleeding is arterial
   - The bleeding appears massive

     Note: External bleeding from the airways is covered on page 58.
4. Ensure an open airway (with C-spine control if the mechanism of injury suggests spinal trauma).
5. If the patient does not respond with clear speech or if the breathing is distressed, the attendant should ask for helpers to apply direct pressure to the bleeding while the attendant follows the ABCs.
6. If the patient responds with clear speech and the bleeding is arterial or appears massive:

- Expose the wound and apply direct pressure on the wound with dressings.
- If the bleeding is arterial or does not stop with direct pressure, apply a tourniquet while a helper maintains the direct pressure.

7. Prevent unnecessary movement of the affected part. Assess the adequacy of the patient's respirations and intervene as necessary.
8. Assess the radial pulse and the skin for signs of shock, apply oxygen if signs of hypoxia are present, and conduct a rapid body survey.
9. Bandage the wound site and note the time for the tourniquet, if applied.
10. Any patient bleeding severely enough to require the use of a tourniquet is in the rapid transport category (RTC). Following the primary survey and initial management of life-threatening injuries, the patient must be transported rapidly to the nearest hospital. Have the helper maintain support for the injured limb during the move to the stretcher.
11. Reassess the ABCs and:
    a. Check the bandages for rebleeding.
    b. if the wound is still bleeding despite direct pressure, apply a tourniquet
    c. Apply more dressings and bandages over the blood-soaked ones
    d. After rebandaging, reassess the ABCs and check the bandages again

e. If the wound is still bleeding, check that the tourniquet is still tight and make sure the dressings and bandages are directly over the wound site
f. If bleeding still continues, tighten the tourniquet

12. Reassess the ABCs every 5 minutes (RTC) or 10 minutes (non-RTC). Include a check of the bandaged area. Monitor vital signs every 10 minutes (RTC) or 30 minutes (non-RTC) to determine if there is deterioration the urban attendant that has activated BCEHS for transportation should check ABCs every 5 minutes and vitals every 10.
13. Avoid all unnecessary movement or rough handling because such action may restart the bleeding.
14. Protect the patient from the elements or extreme temperatures, and keep him/her comfortably warm.
15. Give nothing by mouth.
16. Conduct a secondary survey. This is done during or while awaiting transport if the patient is in the rapid transport category, or at the scene before treatment if the patient is not in the rapid transport category.
17. When circumstances permit, and if movement could restart bleeding, immobilize the limb or check the effectiveness of previous immobilization.

Special hemorrhage problems

Neck

Bleeding from the neck presents several problems for the attendant. If the bleeding is severe, the attendant must provide immediate and continued direct hand pressure on the wound until medical aid is reached. Swelling associated with this type of injury may also compress the airway. The attendant must monitor the patient for signs of airway problems and treat accordingly.

Any patient with a penetrating wound to the neck that has progressive local swelling or that seems to have penetrated the muscles is in the rapid transport category. This is because of the possibility of airway compression from hidden bleeding or damage to important underlying structures.

Traumatic cardiovascular emergencies

The attendant may be called to attend a cardiovascular emergency. This chapter introduces the attendant to traumatic cardiovascular emergencies. Although contact sports and crushing accidents can also cause cardiac injury, the most common blunt traumatic injury to the heart is caused by impact with steering wheels.

Contusion to the heart

Cardiac myocardial) contusion may be caused either by compression of the heart between the sternum and the vertebral column or by sudden deceleration of the body, causing the heart to be thrust against the chest wall (see Figure 11-1 A mechanism of injury for myocardial contusion). All injured workers with blunt anterior chest trauma are at risk for a myocardial contusion.

Injury to the heart can vary from small areas of bruising to full-thickness contusion of the cardiac wall (see Figure 11-2 Multiple contusions of the heart); the latter may result in immediate or subsequent cardiac rupture.

The most common symptom of myocardial contusion is anterior chest pain, often indistinguishable to that of a heart attack (myocardial infarction) (see page 111, Signs and Symptoms of Heart Attack). The chest pain may start immediately or within a few hours of the trauma. The patient may complain of palpitations (awareness of a rapid, throbbing heartbeat) or of having difficulty breathing, or may be in shock. Myocardial contusion may coexist with a hemopericardium (blood in the pericardial sac) and present with the signs of pericardial tamponade (see the next page). Lethal cardiac rhythms are the major complication of myocardial contusion.

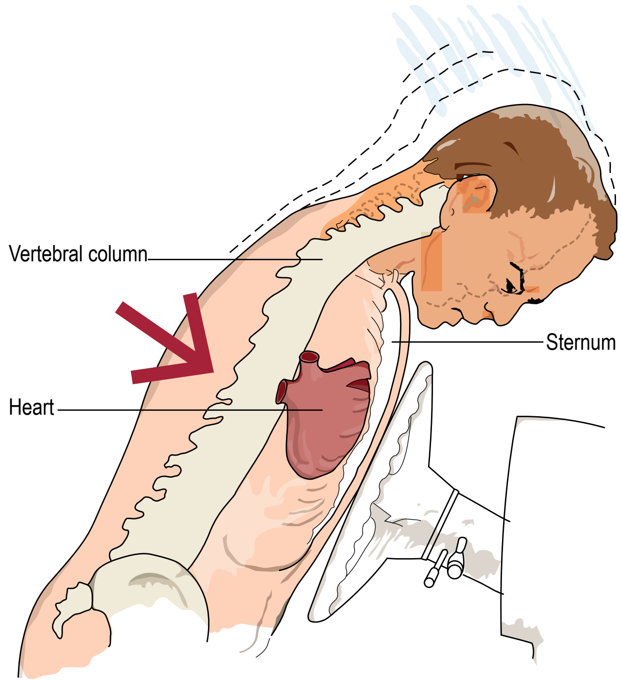

Figure 11-1 A mechanism of injury for myocardial contusion

Management of myocardial contusion

of the patient with suspected myocardial contusion should follow the priority action approach outlined on page 18. All patients with suspected myocardial contusion are in the rapid transport category. When managing such patients, the attendant should follow the General Principles of Management of Chest Injuries outlined on page 65.

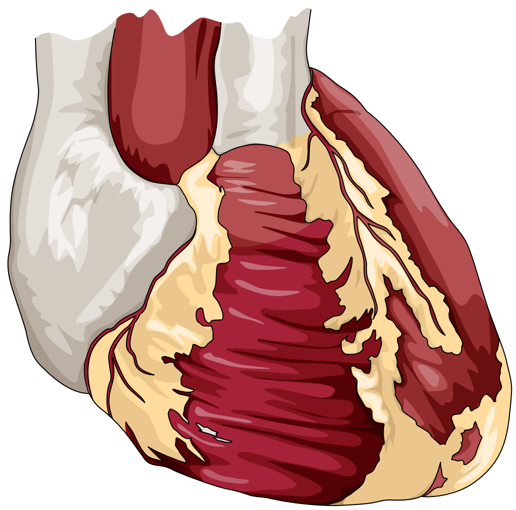

Figure 11-2 Multiple contusions of the heart

Pericardial tamponade

Pericardial tamponade is a condition in which the pumping action of the heart is impaired by compression of the heart by entry of blood or other fluid into the pericardial sac. The accumulated fluid in the pericardial sac must be drained or the patient will soon die from shock.

Recognition of pericardial tamponade

In addition to the general signs of chest injury outlined on page 65, the patient may demonstrate any or all of the following:

- Restlessness
- Air hunger
- Rapid and weak or absent pulse with other signs of shock
- Cyanosis
- Distended neck veins as a result of the backup of blood that cannot get into the heart

Management of pericardial tamponade

This condition is a life-threatening emergency and requires urgent medical attention at a hospital. It should be managed according to the priority action approach outlined on page 18. All patients with suspected pericardial tamponade are in the rapid transport category. When managing such patients, the attendant should follow the General Principles of Management of Chest Injuries outlined on page 65.

Injury of the major vessels

There are several large blood vessels in the chest. Injuries to any of these vessels may cause massive, rapidly fatal hemorrhage. Any patient who is in shock and who has a significant chest injury may have an injury to a large blood vessel. The bleeding may not be apparent, as it remains inside the chest cavity.

The major vessels may be damaged by either blunt or penetrating injuries to the chest, upper abdomen, or lower neck. Other injuries may mask the signs of major vessel damage. Chest pain, dyspnea, back pain, or inability to move the lower extremities may indicate injury to the major vessels. The patient may be in shock. Even without shock, an absent pulse in any limb may indicate major vessel injury in the absence of any other obvious cause — e.g., fracture.

Management of patients with major vessel injury

Patients with major vessel injury may experience life-threatening exsanguination — massive hemorrhage. Such patients are in the rapid transport category. Management should follow the priority action approach outlined on page 18. In addition, the attendant should follow the General Principles of Management of Chest Injuries outlined on page 65.

Non-traumatic cardiac emergencies

This chapter introduces the attendant to non-traumatic cardiac emergencies.

Coronary artery disease

Coronary artery disease is the leading cause of death, killing 75,000 Canadians each year. One-quarter of those who die are under 65 years of age. A majority of deaths from coronary artery disease occur before the person reaches hospital. Of those who do reach hospital, the average time between the onset of symptoms and their arrival is four hours.

While the heart pumps blood to the whole body, it also has its own system of blood vessels to supply its tissues with oxygen and nutrients, and to remove wastes. The two major arteries that carry blood to the heart muscle are the left and right coronary arteries. A heart attack is commonly caused by a sudden obstruction of a coronary artery or one of its branches, with loss of blood supply and oxygen to the heart muscle beyond the obstruction. Although there may be oxygenated blood within the heart waiting to be pumped to the body, the heart muscle is too thick to benefit from this blood and requires its own blood flow through the network, or arteries, arterioles, and capillaries. Disruption of these vessels results in hypoxia of the heart cells and subsequent death of a portion of the heart tissue.

Atherosclerosis

Atherosclerosis is a process by which the arteries become narrowed. The process may take place in the coronary arteries or other areas of systemic circulation, most particularly the brain, the kidneys, and the large vessels of the lower aorta and the arteries of the lower extremities.

Atherosclerosis is a buildup of fatty deposits in the inner walls of the artery. These deposits, known as plaque, are made up of fats such as cholesterol and other particles. The inner diameter of the artery is thus narrowed (see Figure 12-1 Inside of a narrowed artery with atherosclerosis), restricting the flow of arterial blood. Over time, calcium can be deposited at the site of the plaque, causing the area to harden. The hardening of the artery causes the vessel to lose its elasticity, which affects blood flow and increases blood pressure. The plaque causes a roughened surface of the internal lining of the artery, which may lead to blood clots being formed, and these may subsequently obstruct the vessel. The clot may break off and form a plug (embolus). It is the process of atherosclerosis with obstruction of a coronary artery that causes heart attacks.

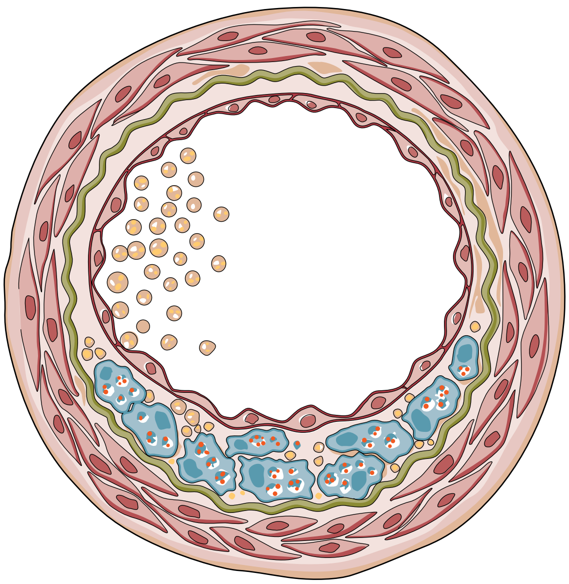

Figure 12-1 Inside of a narrowed artery with atherosclerosis

The following risk factors increase the probability of atherosclerosis and heart attack:

- Smoking
- High blood pressure (hypertension)
- High level of cholesterol or other fatty substances in the blood
- Poor level of physical fitness
- Obesity
- Diabetes
- Family history of heart attacks in middle age
- Prolonged stress

Angina pectoris

The heart muscle works with greater effort when the body is subjected to physical or emotional stress. Healthy coronary arteries will dilate to supply the heart muscle with more oxygen to meet its increased demands.

In the presence of advanced coronary artery disease, the atherosclerotic narrowed vessels cannot dilate to provide for the increased requirements of the heart muscle. Heart muscle becomes starved for oxygen when demand increases. That lack of oxygen may precipitate chest discomfort, which is called angina pectoris. The discomfort is experienced differently by each individual; some describe it as a pain, others pressure, others a tightness. For some, it is a very severe pain; for others, their discomfort or tightness is mild, or vague. The attendant should not assume that because the sensation is not severe that the pain is not significant.

The pain of angina pectoris usually will ease and disappear if the patient rests and the physical or emotional stress ceases. As the heart rate and strength of contraction return to normal, the narrowed coronary arteries can once again meet the heart muscle's decreased demands for oxygen and the chest pain recedes. Angina attacks seldom last more than 15 minutes. If they last longer than 30 minutes, the attendant must presume the patient is having a heart attack.

Signs and symptoms of angina pectoris

The signs and symptoms of an angina attack may vary from person to person, but for each individual the nature of the discomfort is often of the same intensity, duration, and location. As science and medicine progresses, advances in angiographic and surgical procedures means that fewer and fewer people suffer from angina. Many people have their arterial narrowing fixed, and do not suffer from angina anymore. However, if any noticeable changes occur in the individual's regular pattern of angina pain, the patient must be managed as if they are suffering from a heart attack.

Pain or discomfort

- May occur suddenly or build up gradually.
- Is usually located beneath the sternum in the anterior chest and may radiate across the anterior chest. It may be felt in the left or right arm, sometimes as far down as the wrist. It may also radiate up into the neck or jaw or through to the back. Sometimes it is felt only in the upper mid-abdomen and is therefore assumed to be indigestion.
- Angina Pectoris will usually last less than 15 minutes.
- The most common descriptions are of mild to
- moderate pressure, squeezing, or vice-like tightness. It is usually quickly relieved by nitroglycerin tablets or spray taken sublingually — under the tongue — and with the administration of oxygen.
- It is not influenced by deep respiration, coughing, or movement.

Associated signs and symptoms

- Nausea
- Belching
- Apprehension or uneasiness
- Pallor
- Shortness of breath
- Weakness or fatigue

Management of angina pectoris

Individuals suffering from angina are able to carry on reasonably normal lives by taking medications that dilate the coronary arterial blood vessels. Angina sufferers usually carry nitroglycerin (a prescription medication), which they take at the onset of angina pain. The attendant can assist the patient in taking nitroglycerin medication if the patient has it with them. If the patient has taken an erectile dysfunction medication — e.g., Viagra™, Cialis™, or Levitra™ — within the last 24 to 48 hours, then the patient cannot take nitroglycerin. Patients who cannot take angina medication due to taking an erectile dysfunction medication within the previous 24 to 48 hours of the onset of angina pain require urgent medical intervention.

- Nitroglycerin pills are placed sublingually (under the tongue) and allowed to dissolve.
- Spray is also used orally/sublingually according to instructions.
- Some patients may be wearing a nitro patch. Avoid touching it with a bare hand.

The patient should take nitroglycerin only as instructed by a physician. Nitroglycerin should never be given to a patient with chest pain unless it has been prescribed for the patient. It may cause serious complications in some patients who are having a heart attack. The attendant can assist the patient in taking the medication and finding a comfortable position. If applicable, do not delay in providing oxygen unless you can quickly prove that the patient has normal blood oxygen saturations.

Patients with angina pain not relieved by nitroglycerin are in the rapid transport category.

Patients who have taken repeated doses of nitroglycerin may have a weak pulse as a result of generalized blood vessel dilatation. This causes hypotension. On occasion, such patients may have a brief fainting episode. They should be transported in the supine position.

Patients suffering from an angina attack with any of the following symptoms must be assessed by a physician before returning to work:

- Prolonged pain
- Incomplete resolution of symptoms after 1 dose of nitroglycerin
- Sweating
- Shortness of breath

Heart attack (myocardial infarction)

When part of the heart is deprived of oxygen and the condition continues for long enough, the heart muscle cells in that area will die. This is called a heart attack or myocardial infarction (MI).

MI is usually caused by a progressive narrowing of the coronary arteries. This is due to atherosclerotic plaques, which develop over the years in the lining of the coronary arteries. Actual occlusion — blockage — of the artery usually occurs suddenly as a result of a thrombus (blood clot) forming on the rough lining of the artery when the plaque ruptures (see Figure 12-2 Myocardial infarction).

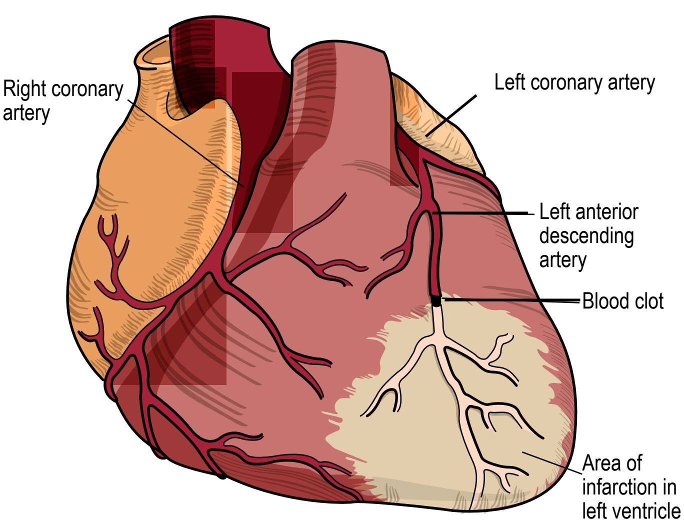

Figure 12-2 Myocardial infarction

Signs and symptoms of heart attack

Chest pain is the classic symptom of most heart attacks (see Figure 12-3 Chest pain of heart attack).

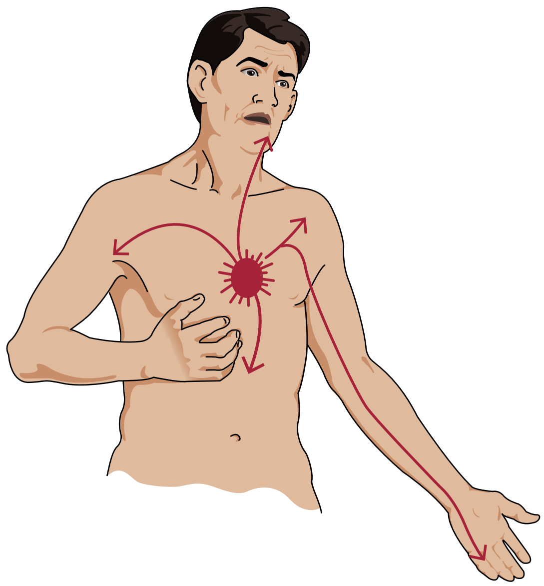

Figure 12-3 Chest pain of heart attack

Pain or discomfort

- It may occur suddenly and may come on when the patient is at rest.
- It is usually substernal — in the anterior chest, beneath the sternum — and often radiates across the chest.
- Some patients may not experience chest pain but may have upper abdominal discomfort usually associated with belching, gas, and indigestion.
- It may radiate to one (usually the left) or both arms, sometimes as far as the wrist. It may also radiate up to the neck and jaw or through to the back.
- It may be described as choking, squeezing, vice-like, burning, or intense. Patients often experience a feeling of pressure.
- It usually lasts longer than 30 minutes and is constant.
- It is not affected by coughing, movement, or deep respiration; relief does not come with nitroglycerin or rest.

Associated signs and symptoms

- Apprehension — the patient may feel they are going to die
- Denial — the patient refuses to accept the seriousness of the symptoms
- Marked weakness, especially in the arms
- Shortness of breath or difficulty breathing
- Sweating, sometimes profuse
- Pallor
- Nausea or vomiting
- Desire to defecate
- Weak and rapid pulse, although in some cases the pulse rate decreases

Three major complications that most often cause death

- Arrhythmia — a disturbance in the heart's rate or rhythm
- Congestive heart failure
- Cardiogenic shock (see page 100)

Sudden cardiac death

Almost half of all patients with acute myocardial infarction die before reaching a hospital. This is most often due to an arrhythmia, an irregular rhythm of the heart preventing effective pumping of blood. The most common lethal arrhythmia is ventricular fibrillation.

This arrhythmia occurs when the ventricles cease to beat with an organized, forceful contraction and all the heart muscle cells contract randomly and independently. With impaired cardiac output, the heart muscles starves for oxygen, and eventually runs out of energy to contract at all. This leads to asystole, which means a cardiac standstill, which is usually a universally lethal arrhythmia.

Sudden cardiac death may also occur as a result of other causes, such as congestive heart failure, pulmonary embolism, or cardiogenic shock.

Management of heart attack

The presence of chest pain in a conscious patient must be considered an urgent priority.

1. Keep the patient quiet and calm. The patient should be supine or in a position of comfort, if dyspneic.
2. Conduct a primary survey.
3. If applicable, do not delay in providing oxygen unless you can quickly prove that the patient has normal oxygen saturations.
4. Keep the patient comfortably warm.
5. Patients with chest pain, suspected of having a heart attack, are in the rapid transport category.
6. A conscious patient should be encouraged to chew and then swallow one adult 325 mg Acetylsalicylic acid (ASA or Aspirin®) tablet or chew and then swallow two low-dose (2 x 81 mg) tablets, if available.
7. Do not allow the patient to move unassisted onto the stretcher.
8. The vital signs should be carefully monitored. Be prepared to perform an intervention if the patient's condition deteriorates, e.g., assist ventilation, if needed, according to the criteria on page 60.
9. Complete the secondary survey while en route while awaiting transportation.

Congestive heart failure

The strength of contraction of the left ventricle is often decreased by myocardial infarction so that the heart fails to pump effectively. The left ventricle cannot pump effectively when it is damaged. Because the ventricle does not empty completely, blood backs up into the left atrium and the pulmonary veins. Pulmonary congestion develops because vessels in the lungs become swollen with blood. Pulmonary edema will develop if excessive back pressure occurs in the capillaries of the lungs, causing plasma to leak into the alveoli and bronchial walls. Pulmonary edema interferes with normal oxygen and carbon dioxide exchange. The pulmonary congestion and pulmonary edema associated with heart problems is called congestive heart failure. Other cardiogenic causes of congestive heart failure, aside from myocardial infarction, include:

- Hypertension
- Valve disease
- Failure to take cardiac medications
- Arrhythmia
- Too much salt in the diet
- Too much exercise or stress in an individual with heart damage

For further details on pulmonary edema, see page 75.

Signs and symptoms of congestive heart failure

History

If caused by left ventricle failure, there may be:

- Chest pain associated with heart attack
- Increased or decreased blood pressure
- History of previous attacks
- History of rheumatic fever or valve disease
- Excess exercise or stress

Dyspnea:

- When severe, inability to lie down
- On exertion
- At night, relieved by sitting up

Physical findings

There may be increasing respiratory distress. The patient may become agitated, apprehensive,restless, or confused. They may exhibit panic and air hunger.

- Chest pain may be present, but it is not a reliable symptom.
- There may be pallor and cold, clammy skin.
- Cyanosis is possible.
- There may be tachycardia, with pulse greater than 100 beats per minute.
- The patient may cough, producing frothy white or pink sputum.
- Wheezing respiration is possible.
- The patient often feels better sitting upright and the dyspnea worsens as the patient lies down.
- Neck veins may be distended.
- Ankles may be swollen.

Management of congestive heart failure

1. Keep the patient quiet and calm. The patient should be sitting upright in a position of comfort with the legs dangling, if possible.
2. Conduct a primary survey.
3. If applicable, do not delay in providing oxygen unless you can quickly prove that the patient has normal oxygen saturations.
4. Periodic rapid suctioning of the airway may be necessary for accumulated secretions, if the patient cannot clear them.
5. If the patient becomes drowsy or extremely dyspneic, assist ventilation with oxygen, timed to the patient's breathing.
6. The comatose patient with acute pulmonary edema may require suctioning, assisted ventilation, and supplemental oxygen to prevent hypoxia.
7. Patients with pulmonary edema are in the rapid transport category.
8. Conduct a secondary survey during or while awaiting transportation.

Summary of chest pain management

Chest pain in the conscious patient should be regarded as a top priority.

Assessing the patient

Primary survey

Assess the level of consciousness. If the patient is unresponsive, open the airway and check for breathing and a carotid pulse for 5-10 seconds — if the patient is hypothermic, up to 30 seconds. If the patient is not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, the need is for CPR/AED rather than examination and assessment. Remember to make sure the ABCs are present before proceeding with anything else.

A — Airway open, with C-spine control if necessary

B — Breathing adequate

C — Circulation assessed and bleeding controlled

Secondary survey

These assessments and questions are conducted during the various components of the secondary survey.

- What are the vital signs?
- When did the pain start?
- How does the patient describe the pain?
- How severe is the pain?
- Where is the pain?
- Does the pain radiate and where?
- What was the patient doing at the onset?
- Is the pain aggravated or lessened with respiration, exercise, or rest?
- Has this happened before?
- Is the patient taking medication?
- What, if anything, is the patient taking for pain?
- Is the patient nauseous?
- Are there any signs of distended neck veins or lower extremity edema?
- Is the patient coughing frothy sputum, which may be bloodstained?

These questions are designed to be a summary of all the important facts about the problem. Answers should be recorded and accompany the patient to the medical facility or be provided to the ambulance paramedics when they arrive on the scene.

Cardiopulmonary resuscitation (CPR)

Tissues, especially the brain, require an adequate supply of oxygenated blood to maintain vital functions. Organ functions will deteriorate rapidly over a few minutes if this supply is interrupted.

Cardiopulmonary resuscitation (CPR) is an emergency procedure used when a person is unresponsive, is not breathing or is not breathing normally and their heart stops beating.

Basic cardiac life support (BCLS) refers to the first aid techniques used to treat cardiac arrest. Advanced cardiac life support (ACLS) includes all the methods of BCLS with the addition of advanced medical procedures — e.g., intubation, defibrillation, and drug therapy.

The priority action approach outlined in this chapter follows the BCLS guidelines recommended by the Canadian Consensus Guidelines Task Force and the International Liaison Committee on Resuscitation, except for the treatment of airway emergency in trauma patients.

Whenever an attendant approaches a patient, the priority action approach must be followed. Cardiopulmonary resuscitation consists of:

Cardiopulmonary resuscitation consists of:

- Artificial circulation for the patient
- Maintaining the patient's airway
- Artificial ventilation for the patient

CPR can be performed quickly and with minimal equipment or help from another person. CPR must be practiced frequently to maintain a high standard. CPR methods are frequently updated as new medical information becomes available. Therefore, the reader should refer to the current guidelines for basic CPR as recommended by the Canadian Consensus Guidelines on First Aid and CPR.

Overview

If the patient is not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, the patient is assumed to be in cardiac arrest. In the most current guidelines, the attendant should administer 30 external chest compressions to artificially circulate the patient's blood. If the patient remains unresponsive, the attendant should open the airway and provide two ventilations using a pocket mask. If the attendant is unable or unwilling to perform ventilations, continuous chest compressions alone (without ventilations) are still effective, especially when BCEHS resources have been activated and the attendant knows they will be on scene within minutes.

External chest compressions, when efficiently performed according to current guidelines, may provide approximately 25% of normal blood flow to the brain. This amount of circulation is usually sufficient to preserve life until cardiac function resumes — often with the use of an automated external defibrillator (AED); see Figure 13-1 — or until advanced life support becomes available.

Figure 13-1 Automated external defibrillator (AED)

When another trained person becomes available, two-rescuer CPR is initiated. If another person with CPR training is not available and the attendant becomes fatigued, it may be possible to train a bystander how to perform chest compressions. Training a bystander how to perform chest compressions will allow the attendant to switch places every two minutes.

CPR is most effective when started immediately after cardiac arrest has occurred. However, this does not mean CPR should not be initiated if there is doubt as to when the cardiac arrest occurred.

All patients who are in cardiac arrest should receive resuscitation unless exceptional circumstances apply.

The following are reasons to NOT start CPR:

- There is clear evidence that death has occurred; for example, if there is decapitation, transection (the body cut in half) or decomposition.
- The adult patient has been documented to have been completely submerged in water for more than 60 minutes. Where doubt exists as to the duration of the submersion, the attendant will follow resuscitation procedures.
- There is a situation involving multiple patients where treatment and transport of patients with vital signs found in life-threatening condition take precedence over those found in cardiac arrest (see page 343, Triage of Patients).
- The patient has an advanced directive (directions given by a competent individual concerning what and/or how and/or by whom decisions should be made in the event that the individual becomes incompetent to make health care decisions) or a do-not-resuscitate (DNR) order (a medical order written by a doctor that instructs health care providers not to do CPR if a patient's heart stops beating).

Resuscitation is continued until one of the following occurs:

- Spontaneous circulation and breathing are restored
- Another person takes over resuscitation efforts
- A higher level of care arrives and assumes responsibility (ambulance paramedics, nurse, physician)
- The rescuer becomes exhausted and cannot continue
- Resuscitation has been ongoing for 30 minutes without even the temporary return of a spontaneous pulse in patients with normal temperatures (this does not apply to patients with hypothermia)

Automated external defibrillator (AED)

An AED is a portable device used to administer an electric shock to the heart and restore the heart's normal rhythm during sudden cardiac arrest (see Figure 13-2 AED kit). If defibrillated within the first minute of collapse, the patient's chances for survival increase dramatically. For every minute that defibrillation is delayed, survival decreases dramatically. If it is delayed by more than 10 minutes, the chance of survival in adults is not very promising. Using an AED can greatly increase the patient's chance of survival.

Sudden cardiac arrest (SCA) is an abrupt, unexpected loss of heart pump function.

Figure 13-2 Automated external defibrillator (AED) kit

The chain of survival

The term *chain of survival* provides a useful metaphor for the elements of the emergency cardiovascular care systems concept. It consists of:

- Don't start CPR if there is a risk to rescuers
- Healthy choices in lifestyle to help reduce the risk of heart disease, stroke, and injury
- Early recognition of the warning signs for heart disease and stroke, and of illness and injury in infants and children, to help reduce delays to treatment
- Early access to BC Emergency Health Services (BCEHS) — simply calling 911 or your local emergency phone number — to bring trained medical help to the scene
- Early CPR started as soon as possible on a person who is unresponsive, has no normal breathing, no visible signs of circulation and no pulse in order to provide oxygen to the vital organs until trained professionals arrive
- Early defibrillation to shock a heart that has stopped beating effectively and to allow it to reset to a normal rhythm
- Early advanced care by trained health care professionals that may be provided at the scene, on the way to the hospital, or at the hospital
- Early rehabilitation following a critical event such as a heart attack or stroke to help the survivor, caregivers, and family face new challenges and return the survivor to a productive life in the community

Electrical activity in the heart

The heart contains an electrical system that sends out impulses that tell the heart when to contract to pump blood. The leader of this electrical system is the sinoatrial (SA) node. The SA node is the heart's pacemaker and usually sends out 60 to 100 impulses per minute in a resting adult.

Abnormal electrical impulses that are life-threatening include:

- Ventricular fibrillation (VF)
- Ventricular tachycardia (VT)
- Pulseless electrical activity (PEA)
- Asystole

Ventricular fibrillation (VF)

- An uncoordinated electrical impulse across the heart
- No pumping action or pulse
- Heart appears to be quivering
- Most frequent rhythm seen in pre-hospital sudden cardiac arrest
- Most effective treatment is defibrillation

Ventricular tachycardia (VT)

When the heart rhythm is so fast that the heart may not have time to fill with blood.

Pulseless electrical activity (PEA)

The SA node sends a signal to contract, but the heart does not respond for some reason (one of those reasons could be there is no blood in the system to pump).

Asystole

When there is no electrical or mechanical activity in the heart (a state of cardiac standstill with no cardiac output).

Defibrillation

VF and pulseless VT are abnormal heart rhythms that need to be defibrillated immediately. The defibrillator will not shock a patient in PEA or asystole, as these rhythms are not treatable with defibrillation. The defibrillator sends a shock through the heart that stops all electrical activity and allows the SA node to regain its role in providing effective electrical impulses. The longer the time between the onset of VF or VT and defibrillation, the smaller the chances of patient survival.

According to the Heart and Stroke Foundation of Canada, the chance of survival from time of onset (not caused by trauma) decreases approximately 7 to 10% for each minute of delay in defibrillation.

Delay in defibrillation	Chance of survival
Less than 1 minute	90%
5 minutes	50%
7 minutes	30%
9 to 12 minutes	10%
More than 12 minutes	2 to 5%

These times can be improved by providing good, high-quality CPR, and other circumstances such as age and temperature.

Part 6

Head and Nervous System

Part 6 Head and Nervous System

Head and nervous system

The nervous system is responsible for maintaining the individual's state of consciousness as well as controlling most body functions. Since ancient times, it has been known that normal conscious behaviour depends on intact brain function. *Consciousness* means the awareness of self and of the surrounding environment. Because the hallmark of brain function is consciousness, any decreased level of consciousness (other than sleep) always indicates abnormal brain function.

The central nervous system is composed of the brain, acting as the control centre, and the spinal cord, connecting the brain to the peripheral nerves. The peripheral nervous system includes the nerves, either sensory or motor or both, that connect the central nervous system to the various body organs. Sensory nerves carry messages about such things as heat, cold, pain, and taste to the central nervous system. Motor nerves carry messages to the muscles from the central nervous system, causing them to contract or relax.

Another system within the nervous system regulates normal body functions. This is called the autonomic nervous system. Parts of this system reside within the brain and make connections through the spinal cord and peripheral nerves to the organs involved. The autonomic nervous system controls body functions — heart rate, blood pressure, digestion, and temperature regulation — that we cannot control voluntarily.

By learning the anatomy of the nervous system, the attendant will be better equipped to understand neurological emergencies such as head injuries, spinal cord injuries, strokes, and seizures.

The brain

The brain, as mentioned earlier, is the body's control centre. It is responsible for monitoring the state of normal consciousness, enabling us to respond to our environment. All sensory and motor functions are controlled by the brain. The brain receives input from all the sensory organs of the body and analyzes the information in specific areas of the brain. The brain responds to the sensory input as required and through its motor functions enables us to walk, talk, smile, etc., and so respond to our environment. The brain also controls all of the body's regulatory mechanisms such as breathing, heart rate, and temperature regulation.

The brain is divided into three major structures: the cerebrum, the cerebellum, and the brain stem (see Figure 14-1 Anatomy of the brain).

The cerebrum

The cerebrum is the largest part of the brain. It is responsible for all voluntary functions. Thinking, memory, pain, emotions — all the higher functions that make us human — are within the various parts of the cerebrum. Anatomically, the cerebrum is physically divided into two halves, or hemispheres, with many interconnections. The left hemisphere controls the right side of the body and the right hemisphere controls the left side of the body. This unique anatomical fact must be remembered by the attendant when assessing patients with neurological emergencies. For example, motor paralysis of the left side of the body usually indicates damage to the right side of the cerebrum.

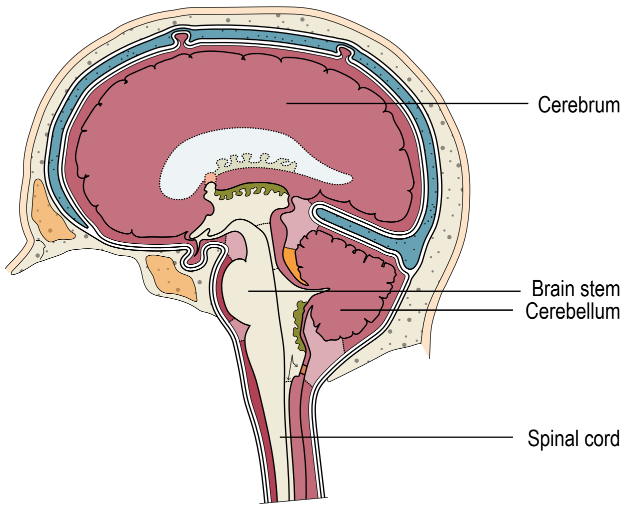

Figure 14-1 Anatomy of the brain

Each half of the cerebrum is further subdivided into four lobes.

Frontal lobe

All voluntary muscle activity is controlled by a small strip of tissue located in the frontal lobe. Swinging a baseball bat or sewing a button — each is controlled by the frontal lobe. The sense of smell is also located in this region.

Parietal lobe

Sensations such as touch, pain, and temperature are interpreted in this area. In most individuals, the speech centre is also located in the left parietal lobe, which has connections to the left frontal lobe.

Temporal lobe

The brain's memory banks are located in this area. As well, hearing is controlled and interpreted in this region.

Occipital lobe

Located at the back of the brain, this area contains the visual centre, where sight is interpreted.

Cerebellum

The cerebellum is a smaller area of the brain located behind and below the cerebrum (see Figure 14-1 Anatomy of the brain). The cerebellum is primarily responsible for coordinating motor activity. For example, the act of walking, which we often take for granted, requires the complex interplay of many different muscles of the body. The ability to walk smoothly and steadily is coordinated by the cerebellum, whereas the actual movement of the limbs is controlled by the frontal lobe of the cerebrum.

Brain stem

The brain stem is located at the base of the brain (see Figure 14-1 Anatomy of the brain). In this region are the centres that control most of our subconscious vital functions, including breathing, blood pressure, and heart rate. The autonomic nervous system, discussed in the chapter on shock, is centred in the brain stem (see page 97, The Body's Response to Shock). Furthermore, all the nerves that control the actions of the face and the special senses — e.g., the tongue, swallowing, eye movements, hearing, facial movements, and sensations — connect to specific centres in the brain stem. Finally, all the nerves connecting other parts of the body to the cerebrum or the cerebellum pass through the brain stem. It is clear that major injuries to the brain stem quickly result in loss of vital functions, severe neurological disability, and often death.

Blood supply to the brain

The two carotid arteries in the neck and the vertebral arteries (two arteries running up through the cervical spine) provide the blood supply to the brain. Injuries to these vessels may reduce blood flow to the brain and restrict its supply of oxygen, glucose, and other essential nutrients, resulting in injury and sometimes permanent damage to affected areas of the brain. Branches of the carotid arteries supply the cerebrum, and branches of the vertebral arteries supply the cerebellum and brain stem. Occlusions — blockages, usually caused by blood clots — in the branches of the carotid arteries are the most common causes of strokes.

The skull and protective coverings

The tissues of the brain are very soft and delicate. The brain is partially supported by three layers of specialized tissues called meninges (see Figure 14-2 Brain coverings). The pia mater is the innermost layer. It lines the surface of the brain. The arachnoid membrane forms the middle layer. The dura mater forms the outermost layer and lines the inner aspect of the skull. These three layers of meninges protect the brain. Meningitis is a serious infection involving the meninges of the brain.

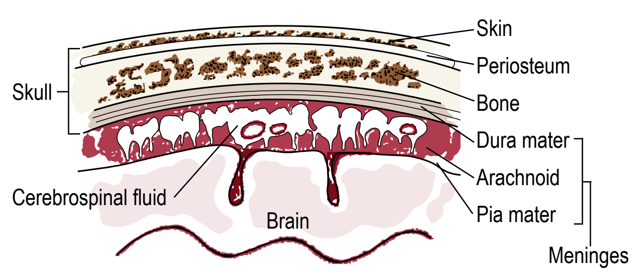

Figure 14-2 Brain coverings

Between the arachnoid membrane and the pia mater is the subarachnoid space. This space is filled with a clear, watery fluid called cerebrospinal fluid (CSF), which completely surrounds the brain. The brain is essentially suspended in the cerebrospinal fluid.

The brain, together with its protective coverings, is completely encased within the skull. The skull is composed of a series of bony plates fused together to protect the brain and give the head its characteristic shape. The forehead, top, side, and back components of the skull are collectively referred to as the vault. The bony plates also extend underneath the brain to form the base of the skull, which separates the brain from the facial structures. The spinal cord is really an extension of the brain stem and exits through the only major opening in the skull, the foramen magnum, located at the base of the skull. Because of the unique anatomical relationship between the brain and the skull, any increase in the size of the brain — e.g., due to swelling or bleeding from injury — is limited by the bony skull. Increasing pressure within the skull (intracranial pressure) may result from injury. If it exceeds a certain level, it will compress the brain stem (the controller of the body's vital functions). Compression of the brain stem will often result in death.

Spinal cord

The spinal cord extends from the brain stem down to the lumbar spine. It is the main cable, carrying all the individual circuits that connect the brain to all the other parts of the body. The spinal cord is contained within and protected by the vertebral column, which is composed of the individual bony vertebrae. Sensory and motor pathways are carried in separate parts of the spinal cord.

The spinal cord and the vertebral column are divided into the cervical, thoracic, lumbar, sacral, and coccygeal portions. There are openings between each vertebra for the spinal nerves. The spinal nerves connect the brain and the spinal cord to their respective body tissues, either muscle or sensory receptors. At each vertebral level, two spinal nerves branch off, one for the left side and one for the right. There are 31 pairs of spinal nerves. Each spinal nerve contains both sensory and motor fibres.

Branching off the cervical portion of the spinal cord are eight pairs of cervical spinal nerves that supply all the muscles and skin of the arms as well as the diaphragm. Similarly, the 12 pairs of thoracic spinal nerves leave the spinal cord in the thoracic region and supply the muscles and organs contained within the thorax and the abdomen. Finally, the muscles and other tissues of the lower extremities are supplied by spinal nerves arising from the lumbar and sacral portions of the spinal cord. There are five pairs of lumbar spinal nerves, five pairs of sacral spinal nerves, and one pair of coccygeal spinal nerves. The sacral portion of the spinal cord supplies the genital area.

Cranial nerves

The skin, muscles, and special sensory organs of the head and neck region are supplied by 12 pairs of special nerves that do not branch off the spinal cord. These are called the cranial nerves and they travel through special holes, or foramina, in the skull to connect directly with the brain stem. The cranial nerves connect to those centres of the brain stem that control the special sense — e.g., sight, hearing, taste, and smell. They also control facial movements and sensation, swallowing, eye movements, and pupillary reaction.

Together, the brain and the spinal cord make up the central nervous system. The cranial nerves and spinal nerves, with all their branches, make up the peripheral nervous system.

Function of the nervous system

To recognize and treat neurological emergencies, the attendant must have a basic understanding of how the nervous system works. The following examples illustrate how the nervous system is organized and how it functions. When an individual wants to wiggle the big toe of the left foot, an electrical signal is generated in the toe section of the right frontal lobe of the cerebrum. This electrical signal is carried down a nerve fibre through the brain stem, and then crosses over to the left side of the spinal cord. The electrical signal continues down the same nerve fibre through the cervical and thoracic portions of the spinal cord until it reaches the lumbar section. There, it connects with the spinal nerve that controls the muscle that moves the left toe. When the electrical signal reaches that muscle, located in the left leg, it causes the muscle to contract, thereby moving the left toe. If we consider an individual who is 2m (6 ft.) tall, it is incredible to think that a small electrical signal generated in the top of the head travels almost 2m (6 ft.) down to the left big toe in just a few microseconds.

What happens when an individual pricks the index finger of the right hand with a needle? Pain fibres in the tip of the right index finger are stimulated by the injury and they generate a small electrical signal that is carried by the sensory nerve fibres located in the index finger. The electrical signal is carried along this particular branch of the appropriate spinal nerve serving the right arm, ultimately connecting to the spinal cord in the cervical region.

Nature has created a unique mechanism for reacting to pain. When the pain signal from the pricked finger reaches the spinal cord, two things occur. First, the electrical signal triggers stimulation of the appropriate motor nerve fibres in the same cervical section of the spinal cord. A new electrical signal is then carried from the spinal cord along the spinal nerve serving the muscles of the hand and forearm that cause withdrawal of the injured index finger. By reflex, the individual withdraws the finger from the offending needle prick. Second, another electrical signal is also transmitted up the spinal cord toward the brain. These fibres soon cross over to the left side of the spinal cord and pass up through the brain stem and into the left parietal lobe of the cerebrum, where the pain centre is located. The brain then triggers its own response: for example, a yell. The important point to remember is that the body responds to pain with a reflex withdrawal controlled by the spinal cord before the brain has had the opportunity to receive the pain signal and initiate its own response. This constitutes one fundamental aspect of self-preservation.

The tissues of the brain are highly dependent on adequate supplies of oxygen and blood sugar (glucose) to function properly. Approximately 15% of the heart's output is required to maintain normal cerebral function. If brain cells are deprived of oxygen for 4 to 6 minutes, they may die or be permanently damaged. That is why the priority action approach ranks airway and breathing first.

Shock associated with low blood pressure (hypotension) can cause brain dysfunction. Even though the body responds by trying to maintain perfusion of the vital organs, as discussed in the chapter on shock, a point may be reached where cardiac output is insufficient to adequately perfuse the brain's tissues. As a result, brain dysfunction ensues. It often begins with lethargy and weakness, and progresses to a decreased level of consciousness. In the setting of major trauma with hypovolemic shock, it can be extremely difficult to determine whether the patient's loss of consciousness is due to head injury or to the presence of shock, or a combination of both.

Perfusion of the brain's tissues is extremely important to maintain proper cerebral function. That is why the priority action approach ranks C for circulation third on the list of priorities in a patient who is breathing normally. If the patient is unresponsive and not breathing or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest. In this case, CPR/AED is initiated according to Part 5, Chapter 13. In patients with an altered level of consciousness and hypotension, the attendant should assume that the altered level of consciousness is due to shock.

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Patients with an altered level of consciousness

The attendant may be called upon to treat an unconscious patient. In this section, the attendant will learn how to assess and treat a patient with an altered level of consciousness using a logical, systematic priority action approach.

Common causes of an altered level of consciousness

By understanding the common causes of altered levels of consciousness, the attendant is better prepared to focus on patient assessment. The attendant must remember that patients can have more than one cause of an altered level of consciousness. A patient intoxicated with alcohol may also have a serious head injury. The attendant must never attribute a patient's altered level of consciousness to alcohol or drugs when there is any evidence of head injury or other medical conditions — e.g., diabetes.

The following mnemonic is extremely useful to remind the attendant to search out all possible causes of an altered level of consciousness: A-E-I-O-U-T-R-I-P-S.

A — Alcohol

Considerations:

- Is there alcohol on the patient's breath?
- Are there alcohol containers lying around?
- Do any friends or bystanders know that the patient has been drinking?

E — Epilepsy

Considerations:

- Have bystanders witnessed any seizure-like activity?
- Is the patient having a seizure at the time the attendant arrives?
- Does the patient have a history of epilepsy or seizure disorder?
- Is the patient wearing a medical alert bracelet?
- Does the patient take medication for seizures?
- Has the patient had involuntary urination?

I — Insulin (diabetes)

Considerations:

- Does the patient have diabetes?
- Is the patient wearing a medical alert bracelet?
- Is the patient taking insulin (injections) or other medications (pills) for diabetes?
- Both can cause low blood sugar and, in severe cases, seizures or coma.

O — Overdose

Considerations:

- Wmedication is the patient taking?
- Has the patient taken an overdose of medication?
- Is there evidence of pills missing?
- Is there evidence of a suicide attempt?
- Does the patient use drugs intravenously?
- Are there syringes or needles around or on the patient?
- Does the patient have recent needle-puncture wounds (track marks)?
- Is there a history of narcotic use?

U — Uremia (kidney failure)

Patients with severe kidney failure can deteriorate into coma from the accumulation of waste products that the kidneys are unable to excrete. The attendant will rarely encounter such patients in the workplace because of their chronic disability.

T — Trauma

Considerations:

- Is there evidence of major trauma?
- Has the patient suffered a head injur?

R — Respiration

Considerations:

- Does the patient have an airway obstruction?
- Is the patient in cardiac arrest?
- Was the patient drowning?
- Does the patient have evidence of respiratory failure?

I — Infection

Considerations:

- Does the patient have a fever?
- Has the patient recently had an infection?

P — Poisoning

Considerations:

- Has the patient been exposed to any toxic gases or materials — e.g., carbon monoxide?

S — Stroke

Considerations:

- Does the patient have a history of high blood pressure?
- Did the patient complain of a severe headache prior to the onset of the altered level of consciousness?
- Is there evidence of paralysis involving one side of the body?

Using the mnemonic A-E-I-O-U-T-R-I-P-S, the attendant will be able to record all the information needed to help identify the cause of a patient's unconscious state. When a patient has an altered level of consciousness and is unable to provide any history, information must be obtained from friends and witnesses. A careful search must be made of the patient's clothes and valuables — e.g., wallet — for pill bottles, syringes, medical alert bracelets or cards, etc.

Levels of consciousness

In the past, the word coma was used to describe patients who were unconscious. As explained in the previous chapter, consciousness refers to the awareness of self and of the surrounding environment. Obviously, there are different degrees of consciousness, varying from fully alert to unresponsive. Rather than relying on subjective terms like sleepy or semi-conscious, the attendant should refer to the Glasgow Coma Scale (GCS) to determine the patient's level of consciousness (see page 35, Glasgow Coma Scale). The GCS provides an objective scale by which the attendant can determine the level of consciousness and communicate this to other care providers. Truly comatose patients generally are unable to open their eyes to any stimulus, unable to speak coherently, and unable to move voluntarily. This corresponds to a Glasgow Coma Score of 8 or less. Patients with a higher Glasgow Coma Score are described best as having a decreased level of consciousness.

Some patients may have a normal Glasgow Coma Score but function abnormally. They may be anxious, drowsy, or aggressive. A simple example is the patient who is intoxicated. The patient's Glasgow Coma Score may be normal (15/15), but they are obviously impaired, appearing agitated, drowsy, and/or belligerent.

Finally, the duration of unconsciousness is important. The patient who has a brief episode of unconsciousness, then recovers fully, is said to have had syncope (fainting). Syncope has many different causes — e.g., fear, pain, heart disease, stroke. The patient with syncope is assessed in exactly the same way as the patient with decreased level of consciousness.

Priority action approach for patients with altered level of consciousness

Despite the many causes of an altered level of consciousness and syncope, assessment and treatment of a patient with a decreased level of consciousness follows the priority action approach, focusing on the ABCs.

1. A — Airway
   Assess, clear, and maintain the airway (see page 23, A for Airway). Stabilize the patient's head and neck if the mechanism of injury suggests spinal trauma.
2. B — Breathing
   Patients with an altered level of consciousness may require supplemental oxygen. Assisted ventilation may also be required according to the criteria on page 60.
3. C — Circulation
   Patients with low blood pressure (hypotension) and shock from any cause may have an altered level of consciousness. The attendant must check the patient's pulses, looking for evidence of hypotension (absent radial pulses) or arrhythmia (irregular or extremely slow or fast pulses). CPR must be initiated if the patient is in cardiac arrest.
4. All patients with altered level of consciousness (GCS of 13 or less) are in the rapid transport category.
5. Vital signs:
   The attendant must determine the level of consciousness using the GCS (see page 35, Glasgow Coma Scale). The attendant must check the pupillary response to light. The presence of a dilated, unresponsive pupil together with a loss of consciousness usually indicates life-threatening structural damage to the brain.
6. History taking:
   The attendant must attempt to gather the patient's relevant medical history from the patient, bystanders, and/or medical alert bracelets or cards.
7. Head-to-toe examination:
   The attendant must conduct a neurological assessment (see page 42, Neurological examination). In the patient with a decreased level of consciousness, sensory function is impossible to evaluate accurately.

The attendant must focus on any differences (asymmetry) in motor response between the left and right sides of the body, including the facial muscles. The presence of any asymmetry in motor activity — e.g., paralysis of one arm — is another clue suggestive of life-threatening structural damage to the brain

8. Patients who are alert at the time of assessment but have experienced a loss of consciousness or a period of confusion, no matter how brief, must be referred for medical assessment. They are not in the rapid transport category unless other criteria indicate this.

Injuries to the head and brain

Treating patients who have an altered level of consciousness presents a great challenge to the attendant. Careful attention to the priority action approach and the neurological examination will optimize the outcome for sucha patient.

Head and brain injuries vary from superficial soft-tissue injuries of the scalp to severe disruption of brain tissue.

Soft tissue injuries of the scalp

The scalp is composed of the skin and soft tissues that cover the skull. Underlying muscles enable us to wrinkle our forehead and chew our food. The muscles that support the cervical vertebrae extend up over the back of the head. Because the scalp and the muscles have a rich blood supply, open wounds may result in extensive bleeding. Similarly, closed wounds may swell rapidly from bleeding underneath the scalp.

A profusely bleeding scalp wound does not indicate that the blood supply to the brain is impaired. The brain obtains its blood supply from the carotid and vertebral arteries in the neck, not from the scalp.

Bleeding usually responds to direct pressure, and bandaging may be required to control the bleeding. If bandaging is required for patients with suspected cervical injury, appropriate cervical spinal motion restriction must be applied. Swelling associated with closed wounds responds best to ice packs if they are available.

All patients with a soft-tissue injury to the scalp must be assessed for possible cervical spine injury and spinal motion restriction applied accordingly.

Skull fractures

If sufficient energy is transmitted to the head, a skull fracture will result. Skull fractures can occur without damage to the brain. Similarly, brain injury (even severe brain injury) can occur in the absence of a skull fracture.

Skull fractures may be classified as linear or depressed. A linear fracture has a single fracture line caused by trauma to the skull. On an X-ray, such fractures resemble straight lines and are therefore called linear fractures. Characteristically, linear fractures are not displaced.

Depressed fractures are usually caused by a localized force — e.g., a blow from a hammer or hard object. A segment of bony skull may be buckled inward. The likelihood of associated brain injury and the need to surgically elevate the bony fragments means transport to medical aid is important for patients with these injuries.

Skull fractures may also be classified as open or closed. A closed-skull fracture occurs with no break in the skin. An open-skull fracture is associated with a scalp laceration. Penetrating injuries to the head from sharp objects or gunshot wounds represent a special subgroup of open-skull fractures.

Skull fractures are further categorized into fractures of the vault and fractures of the base (basilar). As previously described, the bony plates of the skull extend beneath the brain to separate it from the facial structures. Therefore, basilar skull fractures cannot be detected directly and often are not evident on X-rays; computer tomography (CT) scanning is required. The diagnosis of basilar skull fractures by the attendant is made indirectly, by looking for specific signs.

Signs of basilar skull fracture

- Clear fluid (cerebrospinal fluid) leaking from the nose or an ear canal
- Bleeding from inside either ear canal
- Bruising and swelling behind the ear (Battle's sign)
- Bruising around both eyes (raccoon eyes)

Battle's sign and raccoon eyes may not appear until several hours after the injury (see Figure 16-1 Signs of a basilar skull fracture).

Traumatic brain injury

Brain tissue is semi-gelatinous in its normal healthy state. As described on page 120, The Skull and Protective Coverings, the brain is suspended in a bath of cerebrospinal fluid (CSF) and protected by the meninges. When the head is struck with sufficient energy, the brain is essentially bounced around within the skull. Brain tissue may be injured in a number of ways, both traumatic and non-traumatic:

- Concussion
- Direct damage to brain tissue
- Injuries to blood vessels (arteries or veins)
- Inadequate oxygenation (hypoxia)
- Inadequate perfusion (ischemia)
- Combinations of any or all of the above

Figure 16-1 Signs of a basilar skull fracture

Concussion

A concussion is a head injury that causes a brief "short circuit" of the brain. On the CT scan there is no obvious damage to brain tissue. This is the mildest form of brain injury. The brain injury may cause loss of consciousness for a period of time ranging from a few seconds to minutes. However, some patients may only be dazed and not actually lose consciousness. There may be a period of confusion where the patient is disoriented, agitated, or acting inappropriately. There may also be loss of memory (amnesia). The patient may not be able to recall the injury or events leading up to the injury. Associated symptoms usually include headache, dizziness, and nausea. All patients with a head injury severe enough to cause loss of consciousness (no matter how brief), confusion, or other signs of concussion must be removed from work and referred for medical assessment (refer to Figure 16-2). Patients with concussion must also be assessed for an associated cervical spine injury. If a cervical spine injury has been ruled out, the conscious patient may be transported to hospital in a position of comfort — e.g., supine, semi-sitting, or sitting.

Damage to brain tissue

Because brain tissue is rather fragile, a direct blow may bruise or tear it. Depending on the extent and location of the damage, the degree and nature of the neurological deficit will vary.

When the head is struck, the area of the brain directly beneath the location of the blow may be injured. Because the impact causes the brain to shift in the fluid within the bony skull, the fragile tissues directly opposite the site of injury are also damaged from the force of the blow (a contrecoup injury). The bruising of brain tissue is called a cerebral contusion. If bleeding is significant, an intracerebral (within the brain tissue) hematoma (collection of blood) may develop.

Injuries to blood vessels

The arteries and veins supplying the brain may also be injured directly or indirectly from the force of the blow. Bleeding ensues and a hematoma develops (see Figure 16-3 Intracranial pressure). Subdural hematomas are caused by venous bleeding occurring below the dura mater layer. Epidural hematomas are usually caused by arterial bleeding above the dura (between the skull and the dura mater). Epidural hematomas may develop rapidly after injury. Both subdural and epidural hematomas are life-threatening neurological emergencies and usually require emergency surgery. These hematomas may not necessarily be associated with any damage to brain tissue. Some of these patients may have an initial loss of consciousness followed by a period of normal consciousness (a lucid interval) and then subsequent rapid deterioration, with a second loss of consciousness.

Non-emergency concussion signs and symptoms

Thinking and remembering:	Physical:	Emotional and mood:	Sleep:
• not thinking clearly • feeling slowed down • unable to concentrate • memory problems	• headache • fuzzy or blurry vision • nausea and vomiting • dizziness • sensitivity to light or noise • feeling tired or having no energy	• easily upset or angered • sad • nervous or anxious • more emotional	• sleeping more than usual • sleeping less than usual • having a hard time falling asleep

Emergency (red flag) concussion signs and symptoms

You see:	Patient complains of:	Patient is showing:
• repeated vomiting • seizure or convulsion • deteriorating or loss of consciousness	• neck pain • double vision • weakness or tingling/burning in the arms or legs • severe or increasing headache	• unusual behaviour • increasing confusion or irritability

Concussion decision making matrix

Perform Scene Assessment
Identify hazards, mechanism of injury, number of patients, and perform primary assessment. If the patient is non-RTC, conduct the secondary survey at the scene. All patients with signs or symptoms of conscussion must be referred for medical evaluation.

↓

Concussion may be suspected if the patient experienced a direct blow to the head, neck, face, or a hard hit to another part of the body

↓

Is the patient showing any signs or symptoms of concussion?

Yes → Are these emergency (red flag) or non-emergency symptoms?

- **Emergency symptoms** → **Urgent medical aid**
- **Non-emergency symptoms** →
  - Do not send the patient back to work
  - Send patient to a qualified health care professional or hospital
  - Patient returns to work within 24 hours post-injury → When the patient returns to work, follow up with the patient over a two-day period
  - Patient returns to work greater than 24 hours post-injury → Follow up as necessary, according to facility protocol

No → Is the patient at high or low risk for re-injury in the work environment?

- **High risk**
  - Do not send patientback to work
  - Send patient to a qualified medical professional or hospital to avoid re-injury
  - When the patient returns to work, follow up with patient over a two-day period
  - Inform the patient and employer of potential concussion symptoms and red flags
- **Low risk**
  - Send patient back to work and follow up with the patient over a two-day period
  - Instruct patient to report to the attendant on site if symptoms arise
  - Inform the patient and employer of potential concussion symptoms and red flags

Figure 16-2 Concussion decision matrix

Subdural, epidural, and intracerebral hematomas will often expand. Unfortunately, within the tight confines of the skull, there is no room to accommodate swelling from bruising, bleeding, or an expanding hematoma. As swelling increases, the pressure within the skull (intracranial pressure) increases, reducing the supply of blood and oxygen to brain tissue. If the swelling or bleeding increases further, the intracranial pressure within the skull increases dramatically, cutting off blood flow to areas of the brain. If the patient's condition worsens, the intracranial pressure may exceed a critical point, causing a compression of the brain stem, resulting in the shutting down of vital functions and death.

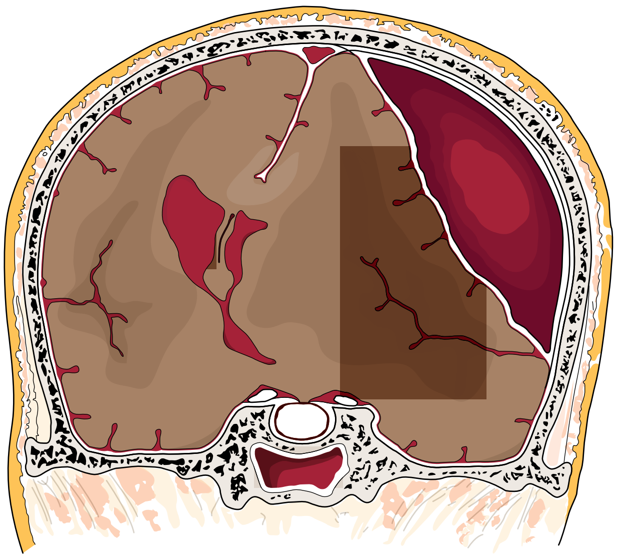

Figure 16-3 Intracranial pressure

Inadequate oxygenation (hypoxia)

As discussed in the section on brain function, cerebral tissue is highly dependent on an adequate supply of oxygen. If brain cells are deprived of oxygen for more than 4 to 6 minutes, permanent brain damage develops. This is why clearing the airway and maintaining breathing rank as the major priorities in first aid.

Certain types of accidents or illnesses cause hypoxic brain injury without direct head trauma. Examples include drowning, choking, and cardiac arrest. The primary treatment in these cases is to restore breathing and circulation as quickly as possible.

Those patients with a significant decrease in their level of consciousness (GCS of 13 or less) have a high probability of severe brain injury. Furthermore, these patients are at increased risk to develop significant swelling or bleeding of brain tissue. The swelling can progress and worsen the patient's condition. Swelling of the brain is increased by hypoxia.

All traumatic injuries that result in airway problems or respiratory emergencies have the potential to cause hypoxic brain injury. In patients with brain injury, failure to correct airway obstruction or hypoxia will worsen the extent of that injury.

Inadequate perfusion (ischemia)

The circulatory system is responsible for maintaining the brain's essential oxygen supply. Failure of the circulatory system — e.g., due to shock or cardiac arrest — will seriously interfere with the supply of oxygen, resulting in brain injury. An occlusion (blockage) of any of the major arteries supplying the brain may also result in brain injury. This is the major cause of strokes (see page 132, Non-Traumatic Brain Injury: Stroke). A stroke illustrates the devastating effect of an ischemic brain injury (see page 132, Signs and Symptoms of Stroke). In major trauma with hypovolemic shock, the body attempts to preserve blood flow to the brain, but at a critical point the cardiac output fails to maintain adequate cerebral blood flow. At this time, shock has the potential to cause ischemic brain injury or to worsen an existing traumatic head injury. This is why circulation ranks third, after airway and breathing, in the priority action approach.

Management of head injury patients

As with all trauma patients, assessment of a patient with a head injury follows the priority action approach, beginning with the primary survey:

1. Conduct the scene assessment. Activate the workplace emergency response procedures as required.
2. Assess the level of consciousness. Attempt to communicate with the patient. If the patient is unresponsive and not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest. In this situation, CPR is initiated according to Part 5, Chapter 13.

3. When the patient is not in cardiac arrest, maintain a clear airway while carefully controlling the motion of the cervical spine to prevent spinal-cord injury. All patients with a head injury have a cervical spine fracture until proven otherwise. Patients with a decreased level of consciousness may require the insertion of an oral airway to maintain the airway. Attempt to insert an oral airway in all patients who do not respond to verbal stimuli, according to the guidelines on page 55, Oral Airway.
4. Assess breathing. All patients with suspected brain injury require supplemental oxygen unless the attendant can quickly prove that the patient's blood oxygen saturations are within physiologic norms. Assisted ventilation may also be required according to the criteria on page 60, Criteria for Assisted Ventilation.
5. Assess the circulation. Head injury patients with evidence of shock and hypotension (decreased or absent radial pulses) are particularly difficult to assess. However, the attendant must remember the following crucial points. In adults, shock and hypotension are almost never caused by brain injury. Shock and hypotension are almost always caused by hemorrhage in other parts of the body. Diligently look for other sources of bleeding, external or internal. The most common causes are intra-abdominal injuries, thoracic injuries, or pelvic fractures. External sources of bleeding must be controlled with direct pressure. Scalp lacerations, even when bleeding profusely, are not usually the cause of shock and hypotension. The attendant must look elsewhere.
6. Using the priority action approach, the attendant may have already determined from the mechanism of injury or the primary survey that the patient is in the rapid transport category. If this is the case, apply a cervical collar and use a scoop-style stretcher to lift the patient onto a well-padded basket stretcher while maintaining stability of the head and neck. Pad and secure them adequately enough to restrict spinal motion without over-tightening.
7. Begin the secondary survey once en route or, if the patient has not yet met the criteria for rapid transport, at the scene. For head injury patients, the secondary survey focuses on the patient's level of consciousness, the patient's pupillary response, the examination of the head, and the neurological assessment.

Examination of head injury patients

Vital signs

Level of consciousness (LOC)

The hallmark of brain injury is loss of consciousness. All patients who are alert must be asked if they incurred a loss of consciousness or were dazed by the event. Patients may not remember exactly what happened, so bystanders should also be asked.

The level of consciousness is best assessed by using the Glasgow Coma Scale. Patients with severe brain injury are those with a GCS score of 13 or less.

Brain injury causes changes over time and the patient's level of consciousness will reflect those changes. If the level of consciousness is improving (GCS increasing), the likelihood of a severe head injury is less. If the level of consciousness is deteriorating (GCS decreasing), the likelihood of a severe head injury is very high.

The most important aspect of the neurological assessment is not only the initial level of consciousness but whether it is changing and if so, the direction of that change.

The patient's condition may not change for hours or even days after injury. It is impossible for the attendant to accurately determine which patients are at risk. All head injury patients who are dazed, confused, have memory loss, or have experienced a decreased level of consciousness require referral for medical evaluation.

Patients with hypoxia or shock and hypotension may also have brain injury in the absence of head trauma. This usually manifests itself as a change in the level of consciousness. It is almost impossible for the attendant to determine whether the patient's decreased level of consciousness is due to head injury, hypoxia, shock, or a combination of all three. Nevertheless, the treatment does not change. All patients with a decreased level of consciousness (GCS score of 13 or less) are in the rapid transport category.

Drugs and alcohol can also cause a decreased level of consciousness. Patients under the influence of drugs and alcohol have an increased risk of injury, especially head injury. Patients with any head injury (even mild bruises, abrasions, or lacerations) who appear intoxicated or impaired from alcohol or drugs must be referred for medical evaluation.

Any patient under the influence of drugs or alcohol who has sustained any trauma to the head or face and has an altered level of consciousness must be assumed to have sustained a brain injury until it is proven otherwise.

Pupillary response

The pupil size and response to bright light is an important aspect in assessing the severity of brain injury. The nerve pathways that control the pupillary response travel from the eyes into the skull and down to the brain stem. These nerve pathways are sensitive to changes in the intracranial pressure.

As discussed previously, swelling or bleeding within the skull causes the intracranial pressure to rise. With a head injury, the swelling and bleeding of brain tissue that cause the rise in intracranial pressure may be delayed in onset. If the intracranial pressure exceeds a critical point, the brain stem becomes compressed and the patient will die. As the intracranial pressure approaches this critical point, the nerve pathways controlling pupil size are usually affected, and one or both pupils will dilate and react sluggishly to light or not react at all (see Figure 16-4 Pupil reaction).

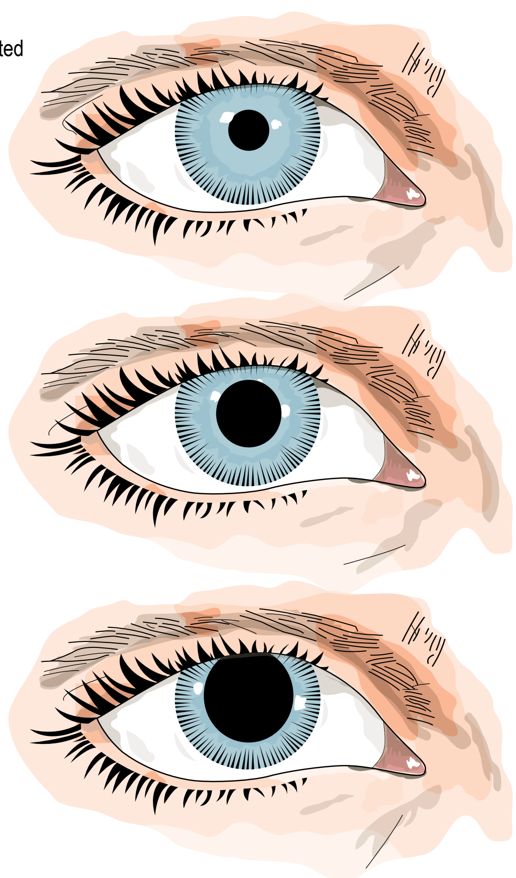

Figure 16-4 Pupil reaction

The presence of a dilated and sluggishly reactive or fixed pupil in the patient with a decreased level of consciousness at the time of initial assessment indicates severe brain injury with probable increased intracranial pressure.

Occasionally, direct trauma to the eye will also result in a dilated, sluggishly reacting, or fixed pupil. These patients may easily be distinguished from those with severe head injury because they are usually alert and has a normal level of consciousness. Patients with a fixed dilated pupil from head injury have a significant decrease in their level of consciousness.

Head-to-toe examination

Examination of the head

The attendant examines the head for evidence of trauma. The attendant must look for the signs of a basilar skull fracture and inspect and palpate for evidence of a depressed skull fracture.

Neurological examination

The rain controls sensory and motor function of the extremities. The assessment of sensory and motor function has already been discussed in detail (see page 42, Neurological examination).

If the patient is able to co-operate, motor and sensory function is relatively easy to assess. The attendant attempts to determine whether there are differences between the left and right sides of the body (asymmetry). If the patient has a decreased level of consciousness, asymmetry of movement may be observed with or without a painful stimulus. Asymmetry of movement or sensation between the left and right sides of the body indicates a severe brain injury. There may not be a significant change in the patient's level of consciousness as determined by the GCS.

Because of swelling or bleeding, the onset of the asymmetry may also be delayed. Once again, frequent reassessments of the patient's neurological status are mandatory.

Complications of brain injury

Convulsions (seizures)

Severe brain injury may cause generalized or focal seizures (see page 134, Types of Seizures). Usually, these do not last more than 10 minutes. There is no particular treatment except to maintain the ABCs. These patients must be upgraded into the Rapid Transport Category.

Vomiting

Patients with brain injury are likely to vomit, especially during transport. The attendant must remain alert to this complication to prevent aspiration (inhalation of stomach contents into the lungs). Patients with a decreased level of consciousness must never be left unattended in the supine position.

If the patient retches or vomits, the attendant must log-roll the patient into the lateral position while maintaining cervical spine motion restriction. The airway is cleared and the patient is repositioned supine.

Non-traumatic brain injury: Stroke

A stroke is the informal term for a cerebrovascular incident (CVA). CVA causes brain damage by the sudden blockage or rupture of a cerebral artery. Strokes result in permanent damage to brain tissue and the person is left with some degree of permanent disability. Strokes are one of the most common causes of serious disability in adults, and they are the third leading cause of death in North America. Some strokes may resolve within a few hours; these are called transient ischemic attacks (TIAs). All patients who have had a TIA must be seen by a physician within 24 hours because of increased risk for a stroke causing permanent damage. Males and females are affected equally. Although most strokes occur in the elderly, they can occur in young, apparently healthy adults.

Types of strokes

There are two main types of strokes: ischemic strokes and hemorrhagic strokes.

Ischemic strokes

Ischemic strokes are caused by the blockage or narrowing of a cerebral artery. The term ischemia means a local deficiency of blood flow. Ischemic strokes account for the majority of strokes (approximately 75%). The mechanism of an ischemic stroke is identical to that of a heart attack.

There are two major types of ischemic strokes

1. cerebral thrombosis
2. cerebral embolism

A cerebral thrombosis develops in the same way as coronary artery disease (see page 109, Coronary Artery Disease). Atherosclerosis develops in the arteries of the brain, causing the vessels to narrow. A small thrombus (blood clot) can then form in the narrowed area, obstructing the blood flow to the brain tissue.

A cerebral embolism is a stroke caused by the obstruction of a cerebral artery by a clot that formed elsewhere in the body (usually the heart) and travelled to the brain. An embolus is not always clotted blood. It may be any foreign material or gas (see page 295, Decompression Illness), which can obstruct the flow of blood to brain cells.

Hemorrhagic Strokes

A hemorrhagic stroke is caused by the rupture of a cerebral artery. Brain damage results from the bleeding into the surrounding brain tissue as well as the impaired circulation caused by the ruptured vessel. The hemorrhage usually occurs at weakened regions of the wall of the blood vessel caused by atherosclerotic damage and high blood pressure. Occasionally, people are born with an abnormal, weakened, dilated area in a cerebral blood vessel (an aneurysm). The rupture of congenital aneurysms is one of the major causes of stroke in young, previously healthy adults.

Signs and symptoms of stroke

The signs and symptoms of stroke vary, depending upon the location in the brain affected and the extent of damage to the brain tissue.

General signs and symptoms of stroke

- Complaints
  - Weakness or loss of use of one or more limbs
  - Loss of feeling (numbness) or a pins and needles sensation in one side of the body
  - Severe headache
  - Nausea and/or vomiting
  - Amnesia
  - Visual difficulties — e.g., partial blindness
- Mental function
  - Decreased level of consciousness
  - Confusion
  - Trouble communicating — e.g., trouble understanding, or having garbled speech
  - Dizziness
  - Seizures
- Change in vital signs
  - Pupils may be unequal in size or may be dilated
  - Pulse may be rapid or very slow and strong
  - Respiration may be irregular
- Motor function
  - Inability to speak or slurred speech
  - Facial weakness, with a one-sided droop of the mouth and/or drooling

- Sudden clumsiness or weakness of an arm or leg
- Paralysis on one (most common) or both sides of the body
- Decerebrate or decorticate posturing (see page 36, for information on the motor response)
- Difficulty swallowing

Quick screen for stroke is recalled by the mnemonic FAST (face, arms, speech, time):

Face

Look for facial droop, facial asymmetry.

Arms

Have the patient hold both arms out straight in front of them, palms up. Have them close their eyes for 10 seconds. If one arm drops or rolls down, it may be a sign of a stroke.

Speech

- Are they speaking normally?
- Oriented to place and time?
- Can they understand you?
- Can you understand them?

Time

Stroke treatment at a hospital is time sensitive. If you think there is an acute stroke, move fast to get the patient to hospital. The attendant should ensure that 911/BCEHS is updated with the stroke screen (FAST) findings as well as any deterioration in the patient's vital signs.

Prior to a stroke, some patients may experience warning symptoms that resemble a stroke but spontaneously resolve after seconds, minutes, or hours. Such an episode is called a transient ischemic attack. It is caused by a temporary blockage of a cerebral artery. Such patients should be treated as though they have had a stroke. They must definitely see a physician. With appropriate care, a complete stroke may be prevented.

Management of the stroke patient

The evaluation and management of the worker with a suspected stroke follows the priority action approach to the injured patient (see page 18). Stroke patients with a decreased level of consciousness will often have airway and respiratory problems. Workers with a suspected stroke are in the rapid transport category

1. Conduct the scene assessment. Activate the workplace emergency response procedures as required.
2. Assess the level of consciousness. Attempt to communicate with the patient. If the patient is not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest. In this situation, CPR/AED is initiated according to Part 5, Chapter 14.
3. When the patient is not in cardiac arrest, ensure an open airway (with cervical spine motion restriction if the mechanism of injury suggests spinal trauma).
4. Insert an oropharyngeal airway if the patient does not respond to verbal stimuli. If the patient does not tolerate an oral airway, frequently reassess their level of consciousness and the need to reinsert the oral airway.
5. Ensure that breathing is adequate by assessing rate and chest movement. Provide assisted ventilation with supplemental oxygen if necessary.
6. Suction the airways as needed.
7. Assess the patient's circulation, control any major hemorrhage, and conduct a rapid body survey.
8. The attendant should package the patient and rapidly transport to a medical facility. Patients who have a decreased level of consciousness should be transported in the lateral or ¾-prone position. The ¾-prone position is acceptable for non-traumatic emergencies, provided there is no concern for spinal injury. If the patient is conscious, transport with the head and shoulders elevated.
9. Obtain a history. The attendant should ask the patient or co-workers if the patient has any medical problems — e.g., past heart disease, high blood pressure, diabetes — and whether the patient has experienced any symptoms of a stroke in the past.
10. Conduct a secondary survey, including a neurological examination as described on page 42, Neurological examination.
11. En route to the hospital, the attendant must check for changes suggestive of increasing intracranial pressure. Danger signs include:
    - a decreasing level of consciousness over time
    - persistent vomiting
    - a slowing and strengthening of the pulse into the range of 40 to 50 beats per minute
    - increasing pupil size or inequality of the pupils

12. Remember that the patient with a CVA may be unable to speak. Nevertheless, they may be able to hear what is going on, as well as understand what is being said. Invariably, the patient will be upset or frightened and it is important that the attendant use a reassuring manner and be careful of statements made in the presence of the patient.

Non-traumatic brain injury: seizures

Seizures are the manifestation of a massive discharge of electrical impulses from the brain cells. Most people consider the term seizure to mean generalized uncoordinated muscular activity associated with loss of consciousness. In fact, there are many different types of seizures.

When assessing the patient with a suspected seizure disorder, the attendant must keep in mind the different types and causes of seizures. Seizure management follows the priority action approach. Determining the patient's seizure history is an important part of the attendant's work.

Most seizures, although frightening and dramatic, are self-limited. By using an organized approach to assessment and treatment, the attendant will usually prevent any life-threatening complications. Most seizures can ultimately be controlled and these patients can usually lead healthy lives.

Causes of seizures

Patients with epilepsy may have started their seizures at an early age. It is important to differentiate patients with epilepsy (a diagnosed chronic disorder, the hallmark of which is recurrent, unprovoked seizures) from those patients who are having their first-time (undiagnosed) seizure. The onset of the first seizure is potentially more serious and life threatening when compared to patients with established epilepsy who happen to have a seizure.

Seizures may be caused by a variety of conditions, including:

- Not taking prescribed anticonvulsive medication
- Alcohol intoxication and/or alcohol withdrawal
- Drug abuse, withdrawal, or overdose
- Hypoglycemia in diabetic patients on oral medications or insulin
- Stroke/TIA
- Head injury
- Meningitis or other infections of the brain
- High fever, especially in infants
- Severe hypoxia
- Cardiac arrhythmia
- Hypertension, especially in the latter months of pregnancy
- Brain tumour

The attendant should attempt to identify and, if possible, treat the underlying cause.

Seizure disorders

Seizures may occur only once in a lifetime from a specific cause — e.g., a hypoxic episode or an electrical injury. When seizures become chronic — recur at intervals — the patient is classified as having epilepsy. Patients with epilepsy are usually aware of their condition, are usually on regular medication to prevent or lessen the frequency of seizures, and often carry medical alert bracelets or cards to identify their condition. Therefore, the attendant must understand the following:

- Patients having a first-time seizure do not necessarily have epilepsy
- Patients with epilepsy may still have seizures despite being on medication

Types of seizures

Seizures may be classified as generalized or focal/partial, depending on whether the entire brain is involved.

Generalized seizures are generally of two types, tonic-clonic (grand mal) and absence (petit mal).

Focal (also called partial) seizures are also generally of two types: simple partial (focal motor) and complex partial (temporal lobe). The difference between the types of seizures is in how and where they begin in the brain.

Generalized tonic-clonic (grand mal) seizures

Tonic-clonic seizures are the most common type. They follow a classic pattern. Initially, the patient may have a sensation that something is about to happen. The patient may cry out. Such sensations take many forms — e.g., a sound, a feeling of dizziness or anxiety, a characteristic smell — but for a particular patient it is always the same and serves as a warning that a seizure is about to occur. This sensation is called the aura and lasts only a few seconds.

The patient then convulses. This is characterized by a loss of consciousness. The patient usually falls to the ground and has a generalized contraction of all muscles associated with rigid extension of their body. The extremities and trunk are stiff. The patient then develops rapid jerking activity of the extremities, as well as tight jaw muscles and clenched teeth. They may bite their tongue. They often turns blue; breathing becomes loud, forced, rapid, and gurgling. The patient often appears to be in danger of respiratory arrest. Loss of bladder control is also common and involuntary urination may occur. This convulsion is referred to as the ictal phase of the seizure. It may last from one to several minutes but rarely longer.

The convulsion is followed by a period of decreased consciousness, which represents the recovery (postictal) phase of the seizure. During the postictal period, the patient's level of consciousness gradually improves from unresponsiveness to confusion. Slowly, over a period of 10 to 30 minutes, the patient usually regains full consciousness. In the postictal period, the patient's extremities are limp and flaccid as opposed to the rigid and jerking activity seen in the convulsive or ictal period. At the beginning of the postictal period, there may be no response to any stimuli. The patient may also appear to have stopped breathing and be cyanotic. Assisted ventilation may be required, though patients usually begin breathing on their own. When the patient regains consciousness, they are usually confused, with no memory of the seizure. The patient may also be combative during this time. Ultimately, the patient regains their previous neurological status.

Absence (petit mal) seizures

Absence seizures are very brief (less than one minute) and usually occur in children. This type of seizure often goes unnoticed. The patient characteristically stares into space, does not respond to questions, and is unable to speak. Usually, the patient does not fall to the ground or exhibit convulsive activity as in tonic-clonic seizures. Their eyes may remain open and the eyelids may flutter. After the seizure, the patient returns to the previous state and resumes full activity. The briefness of the seizure and the lack of convulsive activity is the reason why these seizures are often unnoticed. Such seizures usually disappear by adulthood.

Simple partial (focal motor) seizures

Simple partial seizures involve only the part of the brain that controls motor activity. Typically, only one part of the body is affected by twitching or shaking — e.g., twitching of one side of the face, jerking movement of one arm or one leg. A simple partial seizure may progress to a generalized tonic-clonic-type seizure. Simple partial seizures may last for several minutes and may recur frequently.

It may be difficult to differentiate a simple partial seizure from a tonic-clonic seizure. The key is whether the patient is unresponsive. The patient who is conscious and responds to verbal stimuli is not having a tonic-clonic seizure.

Complex partial (temporal lobe) seizures

Complex Complex partial seizures are characterized primarily by altered behaviour. They are not associated with a decrease in the level of consciousness or convulsive activity. They often start with a period of dizziness or a strange metallic taste in the mouth, somewhat like the aura associated with tonic-clonic seizures. The seizure itself is characterized by an altered mental status and a display of automatic behaviour. The changes in mental status vary greatly, ranging from mild confusion to uncontrollable anger. The patient may walk about aimlessly, resist any assistance, and seem unresponsive. Hallucinations and disturbances of memory have also been recorded. The patient may also exhibit incessant automatic behaviour such as chewing, grimacing, or fumbling with clothes. The absence of the characteristic loss of consciousness and convulsive activity makes these types of seizures very difficult to diagnose. Often, they are unrecognized for some time or are mistaken for other diseases that cause behavioural disorders.

Status epilepticus

Occasionally, a patient may have a prolonged seizure where the convulsive activity lasts for 20 minutes or more. A patient may have two or more successive seizures without regaining full consciousness in between. These situations define status epilepticus. Status epilepticus is a life-threatening medical emergency. The patient is in the rapid transport category.

History

Many other movement disorders may resemble a seizure. For example, a simple faint associated with trembling of the extremities may be mistaken for a seizure. It is obviously very important to differentiate between true seizures and other disorders that may resemble a seizure. The only reliable method is based on obtaining factual data from the patient and witnesses. It is not the attendant's responsibility to make the exact diagnosis, but obtaining the history is extremely important. The attendant therefore plays a crucial role in patient assessment in such cases. The attendant should obtain the following information from the patient or witnesses in all cases of a suspected seizure.

- Determine and record, if possible, the name and contact information of a direct witness (someone who actually witnessed the event).
- Was the patient unconscious at any time?
- Was the patient unresponsive during the event?
- What was the patient doing prior to the attack?
- Was there an aura?
- Where did the seizure begin — e.g., in an arm or the face — and did it progress to a generalized seizure?
- When did the seizure start and how long did it last?
- In what direction were the eyes looking, or were they closed?
- During the convulsion, were the extremities limp or rigid?
- What was the patient's colour (cyanotic or pale)?
- Did the patient bite their tongue? The attendant should examine the tongue closely.
- Was the patient incontinent of urine?
- Did the patient have a postictal phase of confusion or unresponsiveness and, if so, how long did it last?
- Has the patient had seizures before?
- Is the patient on any anticonvulsive medication? Common anticonvulsant medications are Dilantin™, Phenobarbital™, Tegretol™, and valproic acid. Bring all of the patient's medication to the hospital, if possible.
- Does the patient have any other neurological, respiratory, or cardiac illnesses?

Priority action approach to the patient with a seizure

The cornerstones of first aid treatment of seizures are maintaining an adequate airway and protecting the patient from injury. The attendant can do little else during the convulsive phase of the seizure.

1. Position the patient lying down in the lateral or ¾-prone position to maintain the airway. If a cervical spine injury is suspected (e.g., if the patient has suffered a head injury or a fall) manually stabilize the cervical spine as well as possible during the seizure.
2. Loosen clothing around the neck.
3. Do not try to force an oral airway or bite stick into the mouth of a convulsing patient. This can cause injury and bleeding within the oral cavity, further compromising the patient's airway. Wait until the convulsive activity has ceased. In the postictal phase, the patient is usually flaccid and unresponsive. Clearing the airway (finger sweep or suction) is then easier and more effective. An oral airway may be inserted at this time. Suctioning, if available, is extremely useful at the beginning of the postictal period to clear secretions that have collected in the oral cavity.
4. Attempt to provide supplemental high-flow oxygen by mask to all convulsing and postictal patients. During the seizure, the patient is usually deeply cyanotic and respiratory arrest seems imminent. It is extremely difficult to provide assisted ventilation to these convulsing patients whose teeth are clenched and chest muscles are tense. Provide oxygen at 10 L/min by mask and wait until the convulsions have stopped. Then, assisted ventilation may have to be provided until the patient is breathing adequately.
5. It can be extremely difficult to assess the pulses in a patient who is actively seizing. The attendant may be able to feel only the femoral or carotid pulses. Occasionally, the patient may have to stop convulsing before a pulse can be adequately detected.
6. Patients with status epilepticus are in the rapid transport category. They may have to be transported while still convulsing. In this situation, it is imperative that they be adequately protected in the lateral or ¾-prone position to prevent injury during transport.

7. At the end of the convulsion, the patient is often unresponsive. The postictal phase may vary from 10 to 30 minutes and is rarely longer. Pay special attention to the patient's airway and provide assisted ventilation if necessary. Conduct a thorough examination for injuries sustained before or during the seizure.
8. After managing the ABCs, obtain a complete history of events that surrounded the seizure. As the patient is usually unable to recall the exact sequence of events, bystanders may be able to provide useful information.
9. All patients who have experienced a seizure must be transported to hospital for further medical evaluation. If possible, their medication should be brought with them. Patients with a first-time seizure are potentially at more serious risk than those with established epilepsy.
10. Patients may be partly aware of their surroundings. Take care regarding any statements made about their condition. It should also be remembered that patients with seizure disorders are self-conscious of their condition and should be handled with sensitivity.

Summary

Assessment of patients with head and brain injuries focuses on the ABCs and the neurological examination. The severity of brain injury can be established from the neurological examination in less than one minute by evaluating:

- The level of consciousness using the GCS
- Pupil size and pupillary response to bright light
- Presence of extremity weakness or paralysis

All patients with confusion or who have been dazed from the force of injury must be referred for medical evaluation.

All open wounds should be covered. External bleeding should be controlled with direct pressure. Penetrating wounds to the head with exposed brain tissue or leakage of cerebrospinal fluid should be covered lightly with a sterile dressing.

All patients with head injury must be frequently reassessed, focusing on the ABCs, level of consciousness, pupillary function, and extremity motor and sensory function.

Conscious patients with suspected cervical injury and all patients with a decreased level of consciousness and a history of head trauma must be transported with a cervical collar and spinal motion restriction on a well-padded stretcher.

Head injuries are common and have the potential to cause death or permanent disability. The ultimate outcome in patients with head injuries depends largely on treatment by the attendant. It is hoped that rapid identification, effective initial treatment, and rapid transport of patients with severe head injuries will improve their chances of recovery.

Spinal injuries

Neck and back injuries are a common cause of disability among workers. Most of these injuries are minor and resolve with rest and conservative treatment. At the other end of the spectrum, however, fracture of the bony spine (the vertebral column) has the potential to cause permanent paralysis as the result of spinal-cord injury. The primary rule of first aid — "Do no harm" — is never more important than in the evaluation and treatment of patients with spinal injury. The correct treatment, stabilization, and transportation of patients with spinal injuries may prevent a spinal-cord injury. It is possible to render a patient permanently quadriplegic by improperly caring for a spinal injury. In addition to the physical and emotional disability, the lifetime cost of medical care for a quadriplegic is an expensive burden for the patient and society.

The key to preventing spinal-cord injury is to remember that the spinal cord runs inside of and is protected by the vertebral column. The attendant must always think about the possibility of a spinal injury before moving any trauma patient. In this section, the attendant will learn how to evaluate, treat, package, and transport patients with spinal injury.

Anatomy and function

The spine, or vertebral column, is made up of 33 bony segments, or vertebrae, stacked one on top of the other. The spine extends from the base of the skull to the tip of the coccyx (tail bone).

The vertebrae are divided into five groups

- Cervical
- Thoracic
- Lumbar
- Sacral
- Coccygeal

The first seven vertebrae are the cervical vertebrae and form the bony framework of the neck (C-spine). The 12 pairs of ribs are attached to the 12 thoracic vertebrae. There are five lumbar vertebrae, which form the small of the back. The five sacral and four coccygeal vertebrae are fused together to form the posterior wall of the pelvis. Anterior and lateral views of the vertebral column are illustrated in Figure 17-1.

Each vertebra is identified by its grouping and position. For example, the fifth vertebra from the top is called C5 — the C refers to the cervical group and the five indicates the fifth vertebra down in the cervical group. The 11th vertebra from the top is called T4. The T refers to the thoracic group and the four identifies the vertebra as the fourth one down from the top of the thoracic group. Similarly, L3 refers to the third lumbar vertebra.

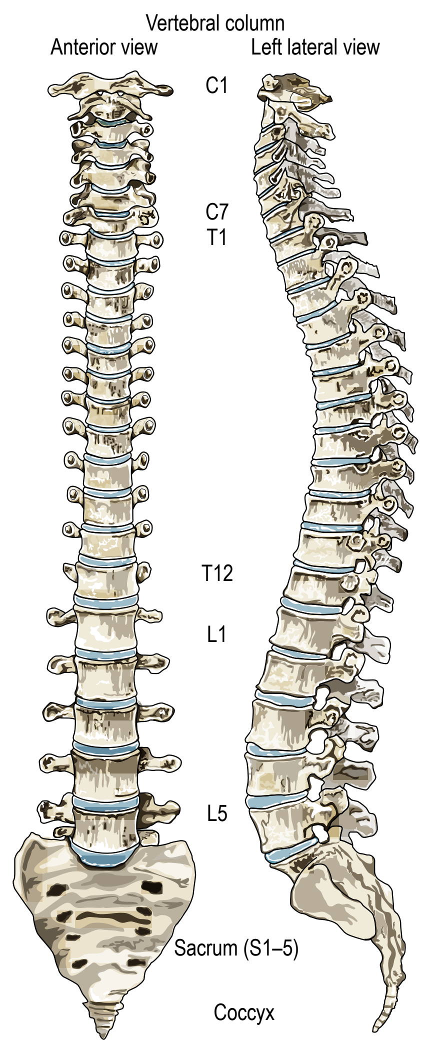

Figure 17-1 Anatomy of the vertebral column

Between each of the cervical, thoracic, and lumbar vertebrae are the intervertebral discs. The discs are composed of a soft nucleus encased in a tough fibrous shell. The discs act like shock absorbers between the vertebrae. They also permit the spine to bend in various directions without kinking the spinal cord inside.

Each intervertebral disc is identified by its adjacent vertebrae. For example, the disc between the 4th and 5th cervical vertebrae is called the C4-C5 disc. Similarly, the L5-S1 disc is the one between the 5th lumbar and first sacral vertebrae.

Each individual vertebra is made up of a bony ring attached to a bony core (the body). The bony ring is composed of the pedicles, the laminae, and the body. The spinal cord passes through the bony ring. The vertebrae are held in a column by specialized joints and ligaments that prevent shifting of any one vertebra on the other. Further, a series of strong muscles run up and down the spine, attaching to each vertebra.

Together, these muscles, ligaments, and joints not only provide support but also give the spine its mobility and flexibility. Figure 17-2 illustrates a top view of a typical vertebra. Figure 17-3 provides a side view, showing how the vertebrae are joined together with the intervertebral discs between them.

The attendant must note the special anatomical relationship among the spinal cord, the spinal nerves, and the bony vertebrae. The bony rings of each vertebra, when stacked one on top of the other, form a long bony canal called the spinal canal, which contains and protects the spinal cord.

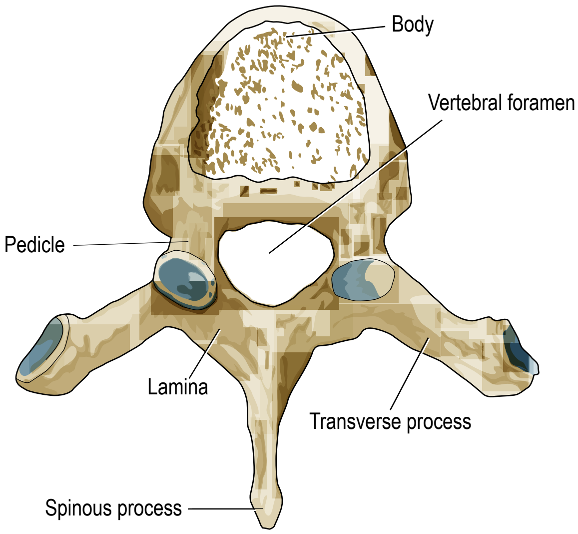

Figure 17-2 Top view of a thoracic vertebra

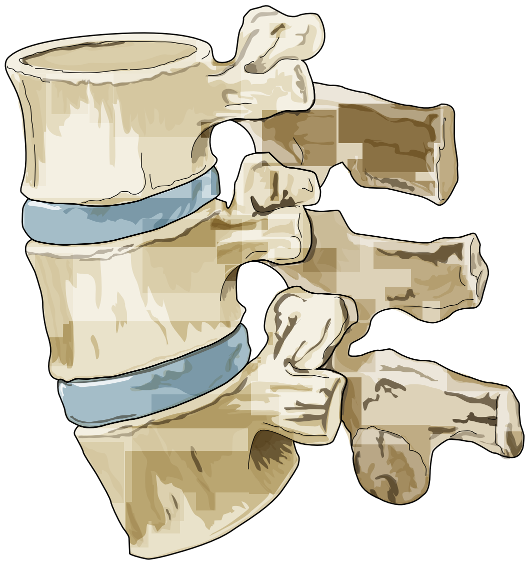

Figure 17-3 Side view of multiple lumbar vertebrae

There are 31 pairs of spinal nerves. Spinal nerves branch off from the spinal cord and connect the brain to the muscles and sensory receptors (see Figure 17-4 Top view of a thoracic vertebra showing spinal nerves and cord). At each of the upper 31 vertebral levels, a pair of spinal nerves branches off the spinal cord — one to the left and one to the right. The spinal nerves leave the vertebral column through bony passages between adjacent vertebrae (see Figure 17-5 Lumbosacral spine showing ligaments and spinal nerves).

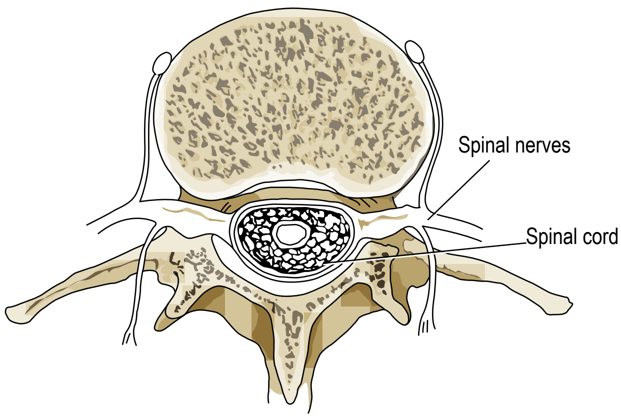

Figure 17-4 Top view of a thoracic vertebra showing spinal nerves and cord

The spinal nerves are numbered according to the level of the spinal column out of which they emerge. The first cervical spinal nerve, C1, exits above the first cervical vertebra below the base of the skull. By consensus, the spinal nerve that exits between C7 and T1 is called C8. The T1 spinal nerve exits below the first thoracic vertebra, T1. As a result, there are eight pairs of cervical spinal nerves. There are also 12 thoracic, five lumbar, five sacral, and one pair of coccygeal spinal nerves.

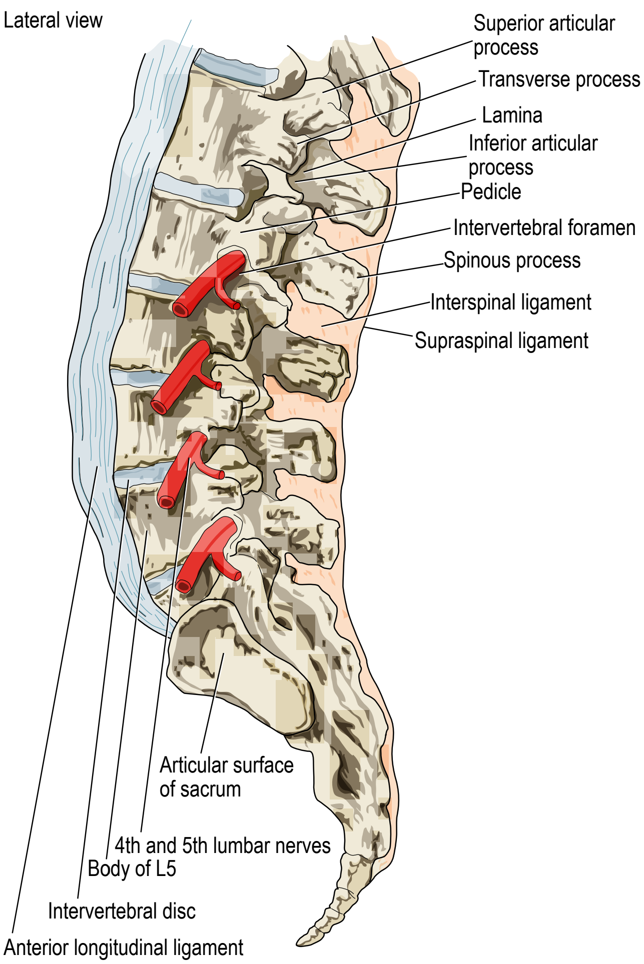

Figure 17-5 Lumbosacral spine showing ligaments and spinal nerves

Because of the tight fit of the spinal cord within the spinal canal, any fracture or ligament tear that allows slight displacement of one vertebra on the next will pinch or shear the spinal cord. This causes a spinal-cord injury.

Similarly, significant narrowing of the bony passageways through which the spinal nerves pass, as a result of fracture, arthritis, or protrusion of the intervertebral disc, may cause spinal nerve injury.

Mechanisms of traumatic spinal injuries

Certain types of accidents must alert the attendant to the possibility of traumatic spinal injury (see Figure 17-6 Mechanisms of a spinal injury). By always thinking about the mechanism of injury and the possibility of spinal injury, the attendant will not miss this diagnosis. In all patients with the following mechanisms of injury, the attendant must assume the presence of a traumatic spinal injury until it has been ruled out.

Figure 17-6 Mechanisms of a spinal injury

- Motor vehicle crashes are the most common cause of spinal fractures and spinal-cord injury. Even when seat belts are worn, the force of the impact can cause spinal (especially cervical) fractures. The frequency of whiplash injuries attests to the high-risk nature of motor vehicle crashes.

Whiplash injury is a muscle and ligament strain of the neck caused by flexion and extension of the neck, which occur on impact. If the force of injury is high enough, cervical spinal fracture results Crashes involving bicycles, motorcycles, all-terrain vehicles (ATVs), and other mobile equipment have an increased likelihood of causing spinal fracture, especially if available seat belts are not worn.

- Falls are another frequent cause of spinal fracture. The height of the fall and the manner in which the body strikes the ground often determine the type and location of spinal injury. Jumping down from a wall and landing on the feet often results in fracture of the lower thoracic or upper lumbar vertebrae. This is especially true if the force of impact is sufficiently strong to fracture the heel bone. The patient who falls down a flight of stairs is also at risk of spinal injury, especially to the cervical spine.
- Any direct blow to the spine has the potential to cause a spinal fracture. Assaults, crush injuries, and blunt injuries from falling or swinging objects are some examples of accidents that may result in fractures of the spine.
- Diving into shallow water such as a lake or pool is another common cause of cervical spine fracture. The attendant must consider the possibility of cervical spine injury when called to rescue a drowning person, especially in shallow water. The management of near-drowning people with suspected cervical spine injury is discussed on page 293.
- Sports injuries also often include spinal fractures Football, rugby, hockey, and gymnastics are some examples of high-risk sports.
- Gunshot wounds, deep knife wounds, and other penetrating injuries may directly injure the vertebral column or the spinal cord.
- Severe electric shock can cause direct spinal cord injury, or it may cause spinal fracture from the violent muscle spasms that often accompany these injuries. Unresponsive people who have had an electrical injury must be assumed to have a spinal injury, and spinal motion should be restricted accordingly.
- Facial and head injuries are also associated with cervical spine fracture. The same mechanism of injury that causes structural damage to the face or head (lacerations, contusions, or fractures) can also result in cervical spine fracture

In summary, the attendant must suspect traumatic spinal injury in all the conditions listed here and treat the patient accordingly. The first step in the treatment of these patients is to “think spinal injury.”

Types of spinal injuries

Injuries to the spine may be classified as follows:

- spinal cord injury
- spinal nerve injury
- vertebral fractures and/or dislocations
- injuries to the intervertebral discs
- strains and/or sprains of the back or spine
- a combination of the above

It is important that the attendant recognize that spinal injury and spinal-cord injury are different entities and may occur independently of each other.

Spinal injuries may be associated with spinal cord or spinal nerve injury but are not necessarily. Even vertebral fractures may not cause spinal cord or spinal nerve injury immediately. Movement of the patient at any time may cause significant displacement of the fracture, resulting in permanent spinal cord or spinal nerve injury. Furthermore, spinal cord injuries may occur in the absence of spinal fractures. In such cases, the spinal cord is injured by tearing, bruising, or swelling.

Spinal cord injury

Approximately 2 to 4% of people with multiple traumas have cervical spine injuries, of which 5 to 15% have a spinal-cord injury.

The spinal cord is similar to a large telephone cable with thousands of individual circuits. Spinal-cord injury is exactly like someone breaking the telephone cable. The break usually occurs at one point along the cable. Similarly, the spinal cord is usually injured in one specific area rather than along its entire length. With the broken telephone cable, service is interrupted only to those households that are connected farther down the line. Circuits that branch off before the break are unaffected. Similarly, spinal-cord injury affects only those areas of the body below the site of the injury.

There are two general types of spinal cord injuries: complete and incomplete. Complete spinal cord injuries result in total loss of motor and sensory functions on both sides of the body below the level of the injury. Incomplete spinal cord injuries result in partial loss. Both complete and incomplete spinal cord injuries affect only those areas below the level of the injury. The degree of motor and sensory function lost depends on the extent and location of the injury. For example, a complete spinal-cord injury at T12 characteristically causes complete paralysis and loss of sensation from the waist down. A fracture at C7, with complete spinal-cord injury, results in partial loss of motor and sensory functions in both arms and complete loss of sensation and total paralysis from the collarbones down. An incomplete spinal-cord injury at C5 will produce partial loss of motor and sensory function in the arms and the legs. Incomplete injuries may worsen with time (because of swelling or bleeding) or with inappropriate handling of the patient, ultimately resulting in a complete injury.

Another physical finding that may be associated with spinal-cord injury in male patients is persistent erection of the penis (priapism). The attendant should not be embarrassed by this finding. It is beyond the patient's voluntary control and the patient cannot feel or notice its development. The attendant should just reassure the patient and protect his dignity by covering him with a blanket.

All patients with spinal-cord injury are in the rapid transport category.

Spinal nerve injury

The spinal nerves are most commonly damaged by conditions that cause narrowing of the bony passageways through which they pass. Fractures, arthritis, or intervertebral disc protrusions may pinch or kink the spinal nerves. Usually only one spinal nerve (the left or right) at one particular level is affected. As a result, the most common findings with spinal nerve injury are pain and partial loss of sensation and motor strength in one extremity. Therefore, patients with pain, tingling, and/or weakness in one extremity may have a spinal nerve injury.

It is extremely difficult for the attendant to differentiate spinal nerve injury from spinal-cord injury or even brain injury. All patients with a mechanism of injury suggesting spinal trauma and any complaints of numbness, tingling, or weakness in one or more extremities must be treated as having a possible spinal-cord injury and are in the rapid transport category.

Vertebral fractures and/or dislocations

As with fractures of the extremities, fractures of the spine may be stable or unstable. Stable vertebral fractures are not at risk for any displacement. Therefore, they involve little risk of causing spinal cord or spinal nerve injuries.

Unstable and/or dislocated spinal fractures carry the greatest risk of spinal cord or spinal nerve injury. They do not necessarily cause spinal cord or spinal nerve injury immediately. Movement of the patient at any time can cause displacement of the fracture and result in spinal cord or spinal nerve injury. Many patients with unstable spinal fractures have walked around the incident scene with little apparent pain. At the scene of an incident with a significant mechanism of injury, it is difficult to differentiate between simple muscle or ligament strains of the spine and unstable fractures or dislocations. Such spinal injuries can be correctly diagnosed only with the help of diagnostic equipment at the hospital.

The attendant must always suspect spinal injury and look for mechanisms of injury that commonly cause spinal injury. The attendant must treat all traumatic spinal injuries as if they are unstable fractures and restrict the spinal motion of every patient with such injuries.

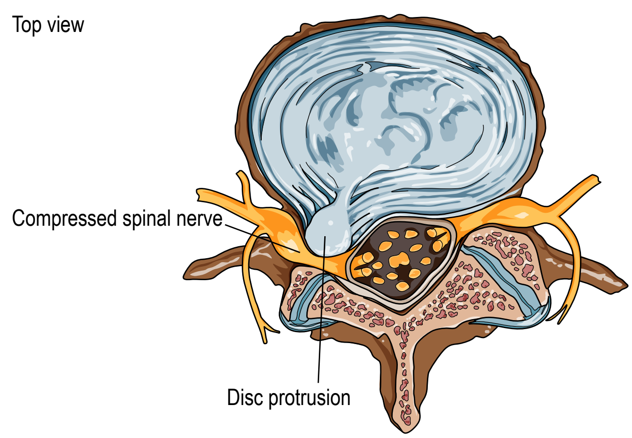

Figure 17-7 Disc herniation

Injuries to the intervertebral discs

The intervertebral discs may be injured suddenly or they may slowly deteriorate with time. Certain types of work — e.g., heavy lifting, long-haul truck driving — may increase the risk of intervertebral disc injury. As mentioned previously, the intervertebral disc consists of a soft nucleus surrounded by a tough fibrous shell. If the shell is damaged sufficiently, it may bulge out under certain conditions. Sometimes, the soft material of the nucleus bulges out through a break in the shell, similar to a bubble in a bicycle tire (see Figure 17-7 Disc herniation). This bulging of the disc or its nucleus (herniation) may cause pinching of the spinal nerve as it passes through the bony passageway out of the spinal canal. What is sometimes referred to as a slipped disc is actually a disc herniation. Discs cannot slip around, as they are firmly cemented in, but they can herniate. Often, the disc heals with a short period of rest, physiotherapy, and a specific progressive exercise program. In more severe cases, surgery may be required. In still other cases, the disc may pinch the spinal cord itself. This depends on the level of the intervertebral disc and may be associated with severe arthritis of the spine. These rare, more serious cases often require surgery.

Strains and/or Sprains of the Back or Spine

The attendant is often called to evaluate patients with neck or back pain as a result of minor non-traumatic injuries such as bending or lifting. Although the pain associated with such injuries can be severe, a spinal fracture is unlikely.

The vast majority of back and spinal injuries are muscle or ligament injuries. Typically, muscle strains or ligament sprains occur when the muscles or ligaments are overloaded, overused, or stretched beyond their normal range — e.g., when the patient lifts a heavy object or twists suddenly. The risk factors for muscle or ligament strains of the back are as follows:

- Previous back injury
- Overloaded muscles or ligaments
- Overuse or misuse
- Poor muscle tone/poor physical conditioning
- Poor posture

The key approach to muscle strains and ligament sprains is prevention. Workers should be encouraged to maintain back fitness and use proper body mechanics in their work.

Signs and symptoms of traumatic spinal injury

Patients with other serious injuries or those who are intoxicated with alcohol or under the influence of drugs may not notice pain in the spine. The attendant must therefore rely on the mechanism of injury and treat these patients accordingly. It is always better to err on the side of caution and restrict the spinal motion of these patients rather than risk a spinal-cord injury.

Pain

Conscious patients invariably complain of pain or stiffness in the affected area of the spine. These patients are usually able to indicate the region of the neck or back that is injured. In the trauma patient it is difficult to differentiate the pain associated with a mild strain from that of a disc injury or a vertebral fracture.

Pain on movement

The patient may voluntarily indicate that movement of the spine causes or increases the pain. The attendant should never attempt to test for this by asking the patient to move unassisted.

Tenderness

The attendant may discover tenderness over the bony projections (processes) of the spine or in the muscles alongside the spine. Tenderness indicates that a spinal fracture may exist.

Numbness, tingling, or weakness

If the conscious patient complains of any tingling, numbness, or weakness in one or more extremities, a spinal cord or spinal nerve injury may exist. It is extremely difficult for the attendant to differentiate brain injury from spinal cord or spinal nerve injury.

Deformity

The presence of any noticeable deformity of the spine is extremely rare and is found only with severe injuries. The absence of a deformity does not rule out the possibility of a spinal fracture.

Swelling

Fractures or other injuries to extremities are usually associated with soft-tissue swelling. However, swelling associated with a spinal injury is very unusual. The absence of swelling also does not rule out aspinal fracture.

Priority action approach for the patient suspected of having traumatic spinal injury

All fully conscious patients with any of the mechanisms of traumatic spinal injury outlined on page 140 and who complain of pain or tenderness in the spinal region must be assumed to have a spinal fracture and spinal motion should be restricted.

All multi-system trauma patients with a decreased level of consciousness must be assumed to have a spinal fracture and spinal motion should be restricted.

All patients with severe head or facial injury must also be assessed for spinal fracture.

The initial assessment of the patient suspected of having traumatic spinal injury focuses on the priority action approach as outlined on page 18. Whether the patient is responsive or not determines the next sequence of events. If the patient is unreponsive and not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest. In this situation, CPR/AED is initiated according to Part 5, Chapter 13.

If the patient has some level of response, the attendant can focus on the ABCs — airway, breathing, and circulation. However, even at this stage the attendant has the opportunity to prevent paralysis by thinking about spinal injury in their approach to the patient. Figure 3-11 Modified NEXUS flow chart (see page 41), outlines the assessment of patients with suspected spinal-cord injury (see also appendices D and E for additional explanations of spinal motion restriction).

1. Conduct a scene assessment. Consider the mechanisms of injury that are known to cause spinal injury. If any are present, movement of the patient must include careful control of the entire spine.
2. Open, assess, clear, and maintain the airway with careful restriction of cervical spine motion. The attendant must use a jaw thrust coupled with gentle and careful realignment of the neck to the neutral position in order to open the airway. This should be done easily, and if any resistance is felt, cease manipulating the neck. Care must be taken when opening the airway of a trauma patient with a suspected cervical spine fracture. In the patient with a decreased level of consciousness, an oral airway is often required. If there is blood, vomitus, or foreign debris in the airway, suctioning equipment is recommended to clear it. Whatever method is used to clear the airway, care must be taken when moving the patient's head and neck.
3. Ensure adequate breathing. Patients with cervical or thoracic spinal cord injuries may have paralysis of the chest wall muscles. These patients may have shallow respiration. If applicable, do not delay providing oxygen unless the attendant can quickly prove that the patient has normal oxygen saturations.
4. Assess the circulation and control any severe external hemorrhage. Patients with spinal-cord injury may develop a shock-like state with decreased pulses as a result of the damage to the pathways of the autonomic nervous system contained in the spinal cord. This is called neurogenic shock. Neurogenic shock occurs only in the presence of a spinal-cord injury with complete paralysis. Neurogenic shock does not occur with spinal fractures alone.
5. Upon completion of the primary survey, the attendant will have determined whether the patient has a mechanism of injury capable of producing a spinal injury and consider applying the modified NEXUS rule at the end of the primary survey. If physical findings suggest a spinal-cord injury, the patient is in the rapid transport category (RTC). Any life-threatening emergency will have been identified and interventions will have been initiated. The RTC patient is then packaged and transported and the secondary survey is conducted en route to medical aid or while awaiting transport.
6. Assess the patient's vital signs.
7. Take a complete history to determine whether a spinal injury exists:
   - Ask the conscious patient if there is any pain or stiffness in the midline of the neck or back. If the patient answers yes, treat them as if a spinal fracture exists. At the scene of an incident with a significant mechanism of injury, it is difficult to differentiate between simple muscle or ligament strains of the spine and fractures or dislocations.
   - If the patient cannot indicate whether a spinal injury exists, assume that a spinal injury is present. For example, the intoxicated patient who falls down the stairs has a mechanism of injury capable of producing a cervical spine injury.
   - The patient may be too drunk to notice any pain in the neck or may be unable to respond appropriately to the attendant's questions. In these situations, the attendant must assume the presence of a spinal injury and restrict the patient's spinal motion accordingly. Similarly, patients with a head injury who are unable to respond appropriately must be treated as if they have a spinal injury.
   - Patients with multiple injuries may be distracted by the pain associated with other injuries and not notice or feel the pain in their spine. Therefore, all patients with multiple-system trauma with distracting injuries must also be treated as if a spinal injury exists.

- Ask the patient if there is any numbness, tingling, or weakness in any of their extremities. Any of those findings, without an obvious extremity injury, indicates a possible spinal cord or spinal nerve injury. Such a patient must be treated as if a spinal fracture is present.

8. Conduct a head-to-toe examination.
   - Gently palpate the spine and the paraspinal (alongside the spine) muscles for tenderness, bleeding, or wounds. If tenderness is found, the attendant must suspect the presence of a spinal injury and treat the patient accordingly.
   - Look for evidence of wounds, swelling, or deformity involving the spine. If evidence of an open wound is found, the patient must be log-rolled at the end of the secondary survey for examination and dressing.
   - Conduct a neurological examination. Check for weakness or paralysis in the upper extremities by asking the patient to squeeze your fingers (hand grip) and to lift their arms. To check the lower extremities, ask the patient to wiggle their toes and test the patient's ankle flexion and extension. Always compare the left and right sides of the patient's body and record your observations. Carefully assess each extremity in its entirety. Sensation may be tested by lightly touching the patient's arms and legs, and asking about numbness or tingling.
9. If any abnormality is detected, the patient must be treated for possible spinal-cord injury. Remember, it is extremely difficult to differentiate brain injury from spinal cord or spinal nerve injury. Furthermore, many head injury patients also have an associated spinal-cord injury. All trauma patients with any unexplained neurological abnormality detected on examination must be treated as though they have a spinal-cord injury
10. If all of the preceding steps have been performed and no evidence of a spinal injury has been found, the attendant should rule out the need for ongoing spinal motion restriction. If any pain or stiffness is found, the attendant must treat the patient as if they have a spinal injury and package them accordingly.

Only if the patient is conscious, reliable and does not have midline neck or back pain can the attendant safely rule out the possibility of a traumatic spinal injury.

Special precautions for patients with spinal cord injury

Patients with spinal-cord injury may be at a very high risk for developing respiratory difficulties and/or pressure sores. The attendant must be aware of the specific complications of patients with spinal-cord injury and take extra precautions to prevent them.

Respiratory difficulties

With cervical or upper thoracic spinal-cord injury, the respiratory muscles of the chest wall are paralyzed. The patient is able to breathe only by movement of the diaphragm, which has a unique nerve supply from the higher cervical nerve routes (C3, C4, and C5). The attendant will therefore observe only the abdomen moving in and out with each respiration and little movement of the chest wall. As a result of this paralysis, the patient with lower cervical or upper thoracic spinal-cord injury will have respiratory difficulties and oxygen must be provided unless the attendant can quickly prove that the patient has blood oxygen saturations within physiologic norms. All such patients will have a decreased ability to cough and clear their secretions, so the attendant must watch for fluid accumulation in the upper airway. Patients with high cervical spinal-cord injury will likely lose function of the diaphragm as well and will likely not be breathing. If the patient is unresponsive and not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest. In this situation, CPR is initiated according to Part 5, Chapter 13.

Spinal injury management

When a spinal injury has been diagnosed or is strongly suspected, the attendant must initiate specific treatment to stabilize the injury. Patients with spinal-cord injury must be quickly and carefully stabilized to prevent further injury to the spinal cord. Patients with a suspected spinal fracture without spinal cord or spinal nerve injury must be carefully stabilized to prevent spinal-cord injury.

Techniques for moving patients with spinal injuries

The general principles of spinal stabilization are similar to the principles governing treatment of injuries to the extremities:

- Prevent further injury.
- With hands on either side of the head, realign by slowly and gently rotating to the anatomical position (see Figure 18-1b). Stop if this is met with resistance, and support in position of greatest comfort.
- Hold the trapezius muscles at the base of the neck when rolling the patient. Ensure that the head, neck, and trunk move as a unit.
- Restrict spinal motion.
- Maximize patient comfort, ensuring that the transport stretcher is well padded. The spinal- injured patient is unable to reposition limbs, and small irritants (sticks or rocks, direct contact with metal stretchers) can rapidly lead to pressure sores.
- Provide oxygen by mask if unable to prove that the patient has normal blood oxygen saturations.
- Keep the patient warm with blankets. This prevents hypothermia.
- Do not give the patient anything by mouth.

Further injury can be prevented by carefully moving the patient as a unit at all times. Even in the presence of life-threatening airway or respiratory emergencies, the patient can be moved rapidly yet with stability of the spine maintained. In most cases, the attendant will require the assistance of at least one co-worker. When other assistants are available, they should be used to support the patient's legs or injured areas. The attendant must assume responsibility for the head and neck whenever the patient is moved.

If a stretcher is readily available, the patient should be moved directly onto it using a scoop-style stretcher to avoid having to move the patient again later.

If the patient is conscious, the attendant should explain ahead of time what will happen to ensure the patient's relaxation and co-operation. The following techniques illustrate the step-by-step procedures to follow when moving the patient and realigning the spine, depending on the position in which the patient is found.

The patient with suspected spinal injury must be carefully realigned to the supine or lateral position. The supine position is preferred because patient assessment and monitoring is easier. Restricting movement of the head and neck is also simpler in the supine position. However, certain specific situations and factors make the lateral position preferable.

Patients with suspected spinal injuries under the following circumstances must be maintained in the lateral position:

- Patients with facial injuries and active bleeding in the nasal or oral airway
- Patients with active vomiting
- Patients with a decreased level of consciousness who cannot be continuously monitored by the attendant
- Stretcher limitations (i.e., inability to rotate the stretcher should the patient vomit)
- Helicopter evacuations (i.e., if the stretcher is suspended below the helicopter during rescue operations, the patient cannot be effectively monitored)

Realignment of the spine

The anatomical position of the spine is a straight line from head to toe without flexion, extension, or rotation. The head is positioned with the eyes forward and the chin in the midline. For proper spine alignment, the head and body must be put in the anatomical position, and then the head must be put in the neutral position. The neutral position is obtained when the patient's head and neck are positioned so that the eyes are looking straight ahead, with the line of vision perpendicular to the axis of the body. Figure 18-1 (a, b, and c) shows the head in the extended, neutral, and flexed positions. The neutral position of the head is obtained as the head and neck are being anatomically aligned. When the neutral position is reached, there may be a gap between the head and the flat surface that the patient is lying on. Without moving the head from the neutral position, the attendant should fill the space with padding (see Figure 18-2 Place padding under head). Never lift the head beyond the neutral position to insert padding. The anatomical and neutral position can be achieved effectively only with the patient supine, or in the lateral position with the head supported. In the ¾-prone position, the spine is not in the anatomical position because there is excessive rotation of the neck.

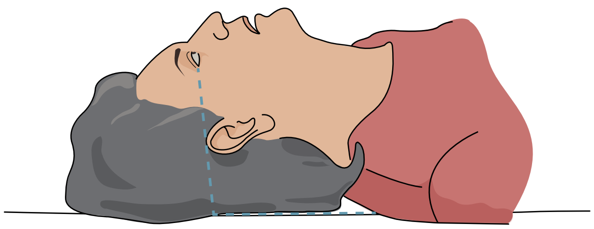

Figure 18-1a Extended

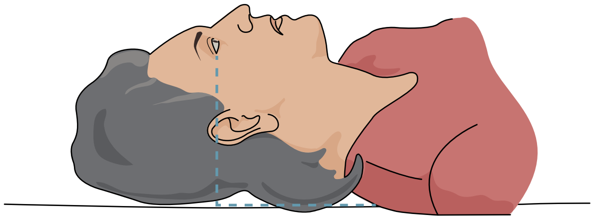

Figure 18-1b Neutral

Figure 18-1c Flexed

To align a patient's spine, take the following steps:

1. Manually stabilize the patient's head and neck by firmly placing your hands on either side of their head, over the ears, and stabilize the hold by placing both your elbows on the ground if possible (see Figure 18-3 Prepare for realignment). Position your hands so that the patient's ears are not completely covered, which will enable them to hear your instructions or explanations.
2. Explain to the patient what is going to be done and the reasons for doing this realignment. Instruct the patient to report any pain or resistance during the procedure.
3. With hands on either side of the head, gently realign the chin to midline (i.e., the anatomical position) and move the head into the neutral position (see Figure 18-4 Realignment to anatomical position). If resistance is met, stop. Do not forcefully rotate the neck. This should not cause increased pain. The head and neck will have to be stabilized and then spinal motion restriction managed in the position found.
4. Manually stabilize the head in the neutral position until the cervical spine has been secured adequately on the stretcher.
5. If the patient's trunk is twisted or rotated, direct an assistant to align the spine while the head and neck are maintained in the neutral position. This is best achieved by having the assistant grasp the patient's waist and gently slide, or pull, the trunk into the anatomical position.

Figure 18-2 Place padding under head

Figure 18-3 Prepare for realignment

Figure 18-4 Realignment to anatomical position

6. Continuously maintain manual stabilization of the head and neck until spinal motion can be properly restricted. This is accomplished by having an assistant take over cervical spine control. Direct this assistant to place their hands over the patient's ears with the elbows stabilized.
7. Applying a hard cervical collar alone is not considered adequate to restrict motion of the cervical spine. Place supports on either side of the head — head-bed, sandbags, other suitable readily available materials, etc.

Spinal motion restriction is achieved only when the patient is secured adequately enough to restrict spinal motion when fully secured to a stretcher.

Log-rolling the patient from prone to supine

The following steps enable the attendant to safely roll the prone patient (see Figure 18-5 Prone patient). This technique requires at least one and preferably two or more assistants.

1. Take a position at the head of the prone patient and kneel to achieve the necessary control of the patient's head and neck. Grasp the patient's
1. trapezius muscle on the side of their head that is closest to the ground.
2. Position the other hand on the patient's head and face, using your fingers to support the head and angle of the jaw.
3. Firmly control the patient's head and neck with your forearm and hand. Support your downward-side arm on your flexed knee or against the ground.
4. Direct an assistant to firmly grasp the patient's shoulder and waist or belt (see Figure 18-6 Prepare to roll). If other assistants are available, have them support the patient's legs and/or injured areas.
5. Direct the assistants to pull the patient toward them and roll the patient as a unit to the lateral position. Maintain alignment of the patient's head and neck with the torso and follow the movement of the assistants. Do not turn the patient's head and neck ahead of the assistant's roll (see Figure 18-7 Patient lateral). The patient must always be rolled in the direction that keeps their face up, unless there are extenuating circumstances — e.g., obstructions in the way of the direction of the roll. The patient's weight must be supported against the assistant's thighs or another assistant must be directed to support the patient in the lateral position.
6. At this point, with the patient in the lateral position, direct an assistant to grasp the patient's cheekbones with one hand. The assistant's hand is stabilized in this position by bracing the forearm and elbow against the patient's anterior chest. Direct the assistant to grasp the patient's lower skull (occiput), posteriorly, with the other hand. This hand is stabilized by bracing the forearm firmly against the patient's back. In this position, the assistant can manually stabilize the patient's cervical spine. Then, and only then, the attendant may release the patient's head (see Figure 18-8 Assistant supports head while attendant changes hand position).

7. If the patient must remain in the lateral position, continuously maintain manual stabilization of the patient's head and neck until the patient's spinal motion can be properly restricted on a stretcher. The assistants may have to support the patient in the lateral position to prevent any rolling, as placing blankets under the patient's head may not be sufficient.
8. Assess and clear the patient's airway as necessary. If there are no contraindications, prepare for the roll to the supine position by grasping the trapezius muscle on the downward side of the patient's head and placing your other hand over the patient's ear, with your elbows supported (see Figure 18-6 Prepare to roll).
9. Direct the assistant to go back to the patient's shoulder and waist while supporting the patient's weight. The roll is then completed to the supine position while maintaining alignment of the patient's head and neck with their torso and following the movement of the assistants (see Figure 18-3 Prepare for realignment).

Figure 18-5 Prone patient

Figure 18-6 Prepare to roll

Figure 18-7 Patient lateral

Figure 18-8 Assistant supports head while attendant changes hand position

Figure 18-9 Assistant takes C-spine control

Figure 18-10 Assistant gets aligned

10. Realign the patient's head to the anatomical and neutral position (see Figures 18-3 Prepare for realignment and 18-4 Realignment to anatomical position).
11. Direct an assistant to take over cervical spine control (see Figure 18-9 Assistant takes C-spine control). Support the patient's head until the assistant gets aligned with the patient; this step should be done quickly but gently (see Figure 18-10 Assistant gets aligned).

Single-person log-roll

When the patient's airway must be quickly drained of vomitus or blood and helpers are not immediately available, the attendant will have to perform a single-person log-roll to the lateral position.

1. Kneel beside the patient at the patient's abdomen.
2. Place one hand at the side of the patient's head and neck.
3. With the other hand, reach across and grasp the patient's clothing just below the waist (see Figure 18-11 Prepare for single-person log-roll).
4. In one smooth movement, roll the patient against your thighs (see Figure 18-12 Single-person log-roll — patient lateral). Cradle the patient's head and neck and try to keep them in line with the rest of the patient's body
5. Position the patient's leg to prevent him or her from rolling fully prone.
6. Position the patient's head in line with the cervical spine.

Figure 18-11 Prepare for single-person log-roll

Figure 18-12 Single-person log-roll — patient lateral

Positioning the patient from standing to sitting to supine

When the mechanism of injury suggests spinal trauma and the patient is standing or sitting, they will have to be positioned supine while restricting movement of the patient's cervical spine to complete the primary survey. If the patient is standing, tell the patient to move slowly and carefully, keeping their head and neck as still as possible, to a sitting position. Once the patient is sitting, remind them to keep their head still and with help, support weight of the patient's head from the side and ask them to lie back into the supine position being careful not to trap your hand under their head. When the patient is supine, move to the top of the patient's head and support their head and neck in position and ask the helper to maintain c-spine control.

Figure 18-13 Patient supine

Patient found on uneven ground or in an awkward position

When the patient is found on uneven ground or in an awkward position, the general principles of spinal realignment apply except that, in this case, the patient must also be moved to a level surface. The procedure outlined below should not be used to carry a patient more than a few metres. It should be used only to transfer patients found on uneven ground onto a level surface or onto a spine board or stretcher.

The attendant will usually require at least three assistants. Two additional assistants may be required to hold and stabilize the stretcher

1. If the patient is conscious, ask them not to move and explain briefly what will happen next.
2. Select a level surface as close to the patient as possible or, preferably, move the patient directly onto a stretcher.
3. Manually stabilize the patient's head and neck by grasping the trapezius muscle on one side of the patient's neck with one hand, and the patient's head and face with the other hand. The patient's head and neck are stabilized between the attendant's hand and forearm.
4. Direct one assistant to hold the patient under the chest and another assistant to hold the patient's waist or belt.
5. Direct another assistant to straighten and free up the patient's legs and then hold the patient's knees together.
6. While continuously stabilizing the patient's head and neck, with the assistants, gently lift the patient as a unit and move them to a level surface or directly onto the stretcher.

Extrication from a vehicle for patients with suspected spinal injury

With the increasing frequency of vehicular crashes, the attendant may face the problem of extricating a patient from a vehicle. In certain instances, the scene assessment will reveal conditions that immediately endanger the patient and/or the attendant (e.g., risk of explosion). Sometimes during the primary survey the attendant identifies a life-threatening condition that cannot be treated adequately inside the vehicle — e.g., respiratory distress requiring assisted ventilation. In such cases, the attendant must remove the patient from the vehicle and then initiate treatment.

In extremely dangerous situations (e.g., fire, rising water) the patient and attendant may be exposed to very high risk. It may be necessary to extricate the patient as quickly as possible without following any protocol.

The following steps will allow the attendant to extricate a patient safely and rapidly from a vehicle:

1. Manually stabilize the patient's head and neck in the neutral position with them sitting upright, and then begin the primary survey. A hard cervical collar may be applied at this point to minimize neck movement during the subsequent procedure.
2. If the scene assessment/primary survey reveals a life-threatening situation, the patient must be quickly extricated from the vehicle. To do so quickly and safely will require at least three and preferably four or five assistants.
3. Slide a spine board onto the seat and slightly under the patient's buttocks and thighs. The patient may have to be lifted gently from the waist by another assistant working from the opposite side. Maintain the patient's head and neck in the anatomical and neutral position throughout the procedure.

4. With one assistant lifting the patient's knees and waist from the opposite side and another assistant holding the upper torso, lift and rotate the patient so that their back is toward the spine board. The patient's legs may have to be carefully manoeuvred to clear the gearshift.
5. Keep the patient's head and neck in line with their body and, with the assistants, lower them to the spine board. Take care that the patient's head clears the top of the door. Slide them to the full length of the board as their legs are carefully straightened.
6. Keep the patient's head and neck in line with their body and, with the assistants, lower them to the spine board. Take care that the patient's head clears the top of the door. Slide them to the full length of the board as their legs are carefully straightened.

Helmet removal

Over the years, there has been a steady increase in the use of helmets for motorcycling all terrain vehicles and bicycling. Furthermore, injuries from hockey or football, where helmets are worn, may also result in spinal injury. The attendant may therefore be faced with a patient who is wearing a helmet. To perform a thorough assessment or provide airway stabilization and assisted ventilation, the attendant must remove the helmet. The following steps will allow this to be done safely with help from at least one assistant.

1. Realign the patient's head to the neutral and anatomical position with the helmet on.
2. Maintain the patient's head and neck in the anatomical position by grasping the trapezius muscles on one side of the patient's neck. Place your other hand on the other side of the patient's head, supporting the lower jaw with your fingers.
3. Direct an assistant to undo or cut the chinstrap. It may also be useful to remove the face shield. With football helmets, the face guard can be lifted out of the way by releasing the clips that hold it to the helmet.
4. Direct an assistant to place one hand on the patient's lower jaw, with their thumb on one side and index and middle finger on the other side. The assistant should place their other hand on the back of the patient's neck at the base of the skull. Direct the assistant to maintain the head and neck in the neutral position.
5. Remove the helmet, keeping in mind the following points:
   - The helmet will have to be widened to clear the ears.
   - If the patient is wearing glasses, they will have to be removed before the helmet.
   - With full-face helmets, the helmet must be tilted up to clear the face. When tilting it up, be careful not to hyperextend the neck.
   - It is better to go slow and easy than to force the helmet off.
   - After the helmet is off, padding may be required to support alignment.

Spinal motion restriction

Once the patient's spine has been realigned to the neutral position, it must be secured in that position. The lumbar, sacral, and coccygeal portions of the spine are adequately secured with the patient in the supine or lateral position on a surface such as a well-padded stretcher or spine board. As long as these elements of the spine are maintained in a straight line and the patient is secured, no additional restriction is required. The body's weight, together with the powerful muscles running up and down the spine, is sufficient to keep movement of the vertebrae reasonably restricted. Patients with only lower spine injuries do not require restriction of the neck using a hard collar unless the patient is in the rapid transport category and the attendant cannot rule out cervical spine injuries at that point in the assessment.

If a cervical or thoracic spine injury is suspected, movement of the patient's head and neck must be restricted.

If the patient is unable to indicate whether an upper spinal injury exists, the attendant must also restrict movement of the cervical spine. All patients with multiple injuries must have movement of their cervical spines restricted. The cervical and upper thoracic spine are much more mobile and therefore the attendant must provide additional padding to restrict spinal movement on the stretcher. Even the patient resting quietly on the stretcher may let their head fall to one side, which would be sufficient to cause further injury to someone with an unstable cervical or upper thoracic spinal fracture.

A number of devices have been developed to immobilize the neck. By itself, no one device, not even the rigid hard collar, adequately restricts movement of the spine. A soft collar does not provide adequate support to prevent flexion, extension, or rotation. Therefore, the soft collar is virtually useless if restricting movement of the cervical spine is required. Even the hard collar alone is inadequate.

The only effective technique currently available for restricting motion of the cervical spine is applying a hard collar and placing supports on either side of the head and securing the patient on a well-padded stretcher.

Spine boards are no longer routinely used for long-distance transports — e.g., an hour or more. In cases where a patient needs to be immobilized for extraction from a situation, securing them to a spine board may be needed, so it is a skill that the attendant must know. Once transported in a more routine manner, on a supported, well-padded stretcher, the patient should be removed from the spine board (to prevent pain and/or pressure sores). Equally important, the attendant must understand when and how to remove the patient from a spine board.

Hard collars

A variety of rigid cervical collars are commercially available for cervical spinal motion restriction. Hard collars are usually made of lightweight plastic or fibreglass and are fully padded. They come in a variety of adult sizes that vary by height (no neck, short, regular, and tall) or may be adjustable. To ensure a proper fit, the attendant should carry all adult sizes or two adjustable collars in the first aid kit. When properly applied, hard collars should not cause airway obstruction and should not interfere with assisted ventilation.

The attendant should use the following general guidelines when selecting a particular brand of hard collar for use at a workplace:

- The collar must firmly support the weight of the head in the neutral position. It must independently provide and maintain adequate support of the neck. It must independently limit lateral movement of the head and neck.
- It must limit rotational movement of the head and neck and limit flexion and extension of the neck (forward and backward motion).
- The collar must not be applied too tightly and should be relatively comfortable when applied.
  - Once applied, the attendant should watch the patient for facial flushing. If the face flushes (red), the collar is too tight, which may lead to increased intracranial pressure and the attendant should readjust it accordingly.
- The collar must be translucent for X-ray examination.
- The collar should fit readily into the first aid kit.
- The collar should be simple to apply, even for individuals unfamiliar with its use. It is not uncommon for attendants to ask bystanders or co-workers to assist in applying these collars.
- The collar should be easy to clean, either with soap and hot water or with a disinfectant.
- The collar must be sufficiently flexible, even in the extremes of cold weather.
- The collar's price should not be exorbitant, so the attendant could stock at least two of each major size.

Sizing and application of the hard collar

Proper sizing of the hard collar is essential for stabilization of the C-spine. Too short a collar does not provide enough support and may compromise the patient's airway. Too tall a collar may hyperextend the neck. The key measurement used for sizing is the distance between the top of the patient's trapezius and a line from the bottom of the patient's chin to the floor.

To size and apply the hard collar, the attendant should carry out the following steps:

1. Ensure that the patient's head is in the neutral position. It may be necessary to place a pad under the patient's head for the neutral position. Direct an assistant to maintain this neutral position during the collar application.
2. Using your fingers, measure the distance between the top of the patient's trapezius and an imaginary line from the bottom of the patient's chin to the floor (see Figure 18-14 Measure the patient for cervical collar).
3. Match this measurement to the corresponding distance on the hard collar. For one type of collar, this is the distance between the black fastener and the lower edge of the plastic portion of the collar (see Figure 18-15 Measure the cervical collar).
4. Assemble the chin piece, if required. For this same type of collar, this is done by sliding the black fastener up and into the small hole. Press firmly to snap it into place.
5. Flex the collar inward to pre-form it to simplify its application.
6. Slide the back portion of the collar containing the Velcro strap behind the patient's neck.
7. Position the front of the collar underneath the patient's chin while maintaining the patient's head in the neutral position. The chin piece of the collar

should rest snugly up against the patient's chin. The lower portion of the collar should rest on the patient's breastbone (see Figure 18-16 Position cervical collar under patient's chin).

8. Tighten the collar by gently pulling and securing the Velcro strap (see Figure 18-17 Tighten cervical collar). The collar should be firmly tightened until adequate support is obtained. Take care not to apply pressure anteriorly over the neck while tightening the collar.
9. After the collar is applied, visually and physically inspect it to ensure the chin piece is under and supporting the patient's chin and is in line with the midline of the patient's body. Loosen, adjust, and re-tighten the collar as necessary.
10. Once the patient has been secured on a well-padded stretcher adequately enough to restrict spinal motion, the collar should not be removed except by a physician or in emergencies — e.g., measurement of an oral airway. If it is necessary to remove the collar:
    - Stop the transport vehicle, if land transport is underway.
    - Direct helpers to support the patient as necessary.
    - Loosen the stretcher straps if they cross the bottom of the collar; this will prevent the neck from flexing.
11. It may be difficult to apply the hard collar on a patient in the lateral position. If the patient cannot be rolled supine because of active bleeding in the mouth, the head and neck must be stabilized as well as possible using appropriate padding and then secured to the stretcher.

Figure 18-14 Measure the patient for cervical collar

Figure 18-15 Measure the cervical collar

Figure 18-16 Position cervical collar under patient's chin

Figure 18-17 Tighten cervical collar

Use of a spine board and carrying devices

Patients may need to be placed on a spine board, to extract them from difficult environments. When possible, the spine board should be removed when an appropriate carrying device is available. Carrying devices include a firm mattress of an ambulance cot or an ambulance cot with a well-padded scoop stretcher. If riding on a rough road, full spinal motion restriction with spine board and collar may feel more comfortable than the movement caused by removing the spine board. For a conscious patient, the end point is comfort and limiting pain. A hammock or sling does not provide appropriate spinal motion restriction. A scoop-style stretcher may be the most appropriate device to safely move a patient from a spine board to a well-padded stretcher such as a basket-style stretcher.

Rolling a patient onto a spine board from supine to supine

1. Ensure any critical interventions are being managed and an assistant is stabilizing the patient's head and neck.
2. Apply a cervical collar if injuries permit.
3. Position the padded spine board close to one side of the patient.
4. Take over support of the head and neck from the assistant and direct the assistant to kneel at the side of the patient across from the spine board.
5. Roll the patient toward the assistant into the lateral position.
6. Direct the assistant to examine the patient's back for obvious wounds or deformities. If wounds or deformities are found, have the assistant assume C-spine control, then examine and dress back wounds as necessary.
7. Direct an assistant to remove hard objects from the patient's pockets.
8. Direct an assistant to pull the spine board close to the patient, slide the blankets used for padding partway off the spine board toward the patient (this will stop the blanket from bunching up on one side when the patient is slid to the middle of the spine board), and then move the spine board right up against the patient's back.
9. Direct an assistant to join their hands, with the elbows out so the forearms are parallel against the patient's torso, and slide the patient as a unit to the middle of the spine board. Ensure that the blanket under the patient does not become wrinkled or bunched up.
10. If it is necessary, direct an assistant to place a pad under the patient's head to maintain neutral position.
11. Direct an assistant to take over support of the head and neck.

Positioning a patient onto a spine board from lateral to lateral

Patients positioned on the spine board in the lateral position must face the attendant when in the rescue vehicle or craft. The attendant must think ahead before moving the patient onto the spine board to achieve this desired position.

1. Ensure that any critical interventions are being managed and an assistant is stabilizing the patient's head and neck.
2. Apply a cervical collar if possible.
3. Position the padded spine board behind and far enough away from the patient that when the patient is rolled supine, they will be halfway on the spine board.
4. Take over head and neck support from the assistant and position another assistant kneeling on each side of the patient.
5. With the assistants, roll the patient to the supine position then quickly to the lateral position onto the spine board. The patient will now be in the lateral position again but facing in the opposite direction.
6. Direct an assistant to place padding under the patient's head, or alternatively, have an assistant take over support of the head and neck, and pad the patient's

head yourself to maintain it in alignment with the body.

7. If the patient's injuries do not permit changing the patient's position — i.e., which side of the patient must be down — maintain head and neck support and with assistants, lift and slide the lateral patient onto the supine board to maintain their original position.

Securing a patient to a spine board

Once the patient's spine has been realigned to the neutral position, a hard cervical collar has been applied (if necessary), and the patient has been positioned on a spine board, the patient may need to be secured for transport. The following points must be considered in safely securing the spine:

- The patient must be secured to the spine board in such a way that it may be lifted, rotated, or even raised vertically without significant patient movement. For example, the patient should be adequately secured to the board so that it can be turned onto its side to facilitate drainage of blood or vomitus should the patient's airway become compromised.
- Spine boards are extremely uncomfortable to lie on for any length of time. By maximizing patient comfort, the patient is less likely to move or become agitated, thereby reducing the risk of further injury. If transport to hospital is prolonged (more than 1 hour) or over very difficult terrain, extra care must be taken to ensure maximum patient comfort. For the supine patient, additional padding should be placed in all body hollows and under all pressure points: the shoulder blades, sacrum, and heels.
- If the patient is in the lateral position, additional padding should be provided under the point of the hip. This step cannot be overemphasized.
- The attendant must ensure that there are no hard objects such as keys, wallets, and belts under the patient to cause discomfort or pressure sores. All securing buckles or knots should be padded so they do not press against the patient. Padding placed down the sides of the patient will help keep the straps from pinching and will aid in controlling lateral motion.
- The head and neck must be secured last. The head and neck must be maintained in the anatomical position manually, or with sandbags, while the rest of the packaging is applied (see page 31).
- The patient will have to be secured to the spine board or stretcher in order to minimize movement. Velcro straps, spider traps, safety-belt-type straps, or triangular bandages may be used. Whichever types of ties are used, they must not loosen under pressure.
- All strapping should allow rapid access to the patient for further assessment. If Velcro straps are used, it is recommended that the straps overlap one another at least 25 to 30 cm (10 to 12 in.) to ensure solid contact. It is important for the patient's comfort that the Velcro be applied with the fuzzy side toward the patient. When the straps are pulled through the slots in the spine board, they should be twisted 180 degrees, tightened adequately and applied to themselves fuzzy side to hooked side. The ties should provide security without constriction.
- The chest straps come up over the top of the patient's shoulders and go under their opposite arms. The securing ties should be high enough on the chest to allow the patient to breathe with minimal restriction and low enough on the abdomen not to cause discomfort. The attendant must remember that the objective is to restrict spinal motion. Do not over-tighten the straps so as to cause discomfort or worse, pressure sores; the position of the securing ties may have to be altered because of injuries.
- If appropriate, the legs should be tied together with padding (e.g., a blanket or a jacket) inserted between them. Secure them with two straps and a tie at the ankles.
- Once the patient's body has been secured in the appropriate position, the patient's head and the neck are further secured by placing appropriate padding or rolled blankets on either side of their head. The patient's head must be secured to the board adequately enough to restrict cervical spinal motion. This is best accomplished with a Velcro strap across their forehead and around the padding and board. A triangular bandage or tape may also be used. If the tape is used in cold or wet conditions, it may not stick to the bottom of the spine board. A dry gauze dressing should be used as a pad between the strap and the patient's forehead. The strap securing the patient's head should be tightened from both sides, ensuring the head is not rotated.
- Securing ties should hold the patient's arms to their body rather than to the device, both for ease of monitoring the pulse and in case intravenous therapy is needed.

- Sufficient padding must be placed under the patient's head so that the head is not pulled downward and out of alignment when it is secured. Extra padding is required in back of the patient, in front of the patient's pelvis and thighs, and in the hollow at their waist.
- A situation may arise in which the attendant must delegate some critical interventions (e.g., assisted ventilation with a pocket mask) to previously trained assistants. In such cases, it is imperative that the attendant frequently recheck the effectiveness of the treatment rendered by the helpers and not become so distracted with packaging or other activities that the patient's condition deteriorates without the attendant's knowledge and the appropriate intervention being overlooked.
- The attendant may have to delegate the packaging procedures to others while attending to critical interventions (e.g., airway management, assisted ventilation, control of major hemorrhage). In such an instance, the attendant supervises others from the head and then checks all the strapping and padding once the critical interventions have been concluded.
- The patient must be kept warm. Cover the patient with blankets and keep the interior of the transport vehicle or ambulance warm. Spinal-cord injury patients are at risk for hypothermia.
- Patients require ongoing monitoring that includes: Reassessment of the ABCs:
  - Every 5 minutes for RTC patients
  - Every 10 minutes for non-RTC patients
  - Every 5 minutes for the urban attendant with a patient requiring transport using BCEHS resources

  Assessment and recording of the vital signs:
  - Every 10 minutes for RTC patients
  - Every 30 minutes for non-RTC patients
  - Every 10 minutes for the urban attendant with a patient requiring transport using BCEHS resources

  Reassessment of the head-to-toe examination every 30 minutes, particularly the head and neurological examination if there has been head injury. Re-examine the chest, and the abdomen, as well as the site of any significant injury.
- The attendant must remember that patients with spinal-cord injury are especially prone to pressure sores. Patients with spinal-cord injury must be removed from the spine board whenever possible. Patients with spinal-cord injury must must be turned be turned slightly every two hours to prevent pressure sores. To do this, the securing straps are loosened, the patient is log-rolled slightly from the supine position to one side and supported with several centimetres of padding, and the securing straps are re-tightened. If transport is occurring over rough roads, the vehicle will have to pull over for this procedure. The next time, the patient is rolled in the other direction to the opposite side and again supported with padding. The attendant should massage the skin areas over the body's bony prominences, such as shoulder blades, sacrum, heels, and elbows, after each rotation.

Pressure sores

When the body is lying down, its prominences are subject to pressure — e.g., the occiput, the shoulder blades, the sacrum and the heels of the feet when lying down supine. This pressure may reduce the blood supply to the skin in those areas. The normal healthy person shifts position slightly or applies padding to prevent the problem. The patient with spinal-cord injury who has lost sensation and motor strength is unable to do so. Over a period of time as short as an hour, the blood supply to the skin over these bony prominences may be reduced enough that the skin and underlying soft tissue are injured or die. This is called a pressure sore. The sore may begin as a reddened mark but may become, over days, a large infected ulcer that extends down to the bone. Its diameter may vary in size from a few millimetres to several centimetres. Pressure sores are a significant cause of morbidity and indeed mortality for the spinal cord–injured patient. They may become infected and often require surgery with skin grafts in order to heal.

Pressure sores are preventable. The attendant must take extra precautions to prevent their development in patients with spinal-cord injury. Hard objects such as keys, wallets, and belts must be removed from under the patient. The stretcher or spine board must be well padded. Padding must be smoothed to avoid wrinkles. The patient must be rotated slightly every two hours.

Summary

The best first aid for spinal injuries is to always think about spinal injury during patient assessment and treatment. By remembering the mechanisms of injury associated with spinal injury and then carefully looking for the signs and symptoms of spinal injury, the attendant will minimize the risk of spinal-cord injury. Once the attendant has suspected or diagnosed a spinal injury, the correct techniques for spinal realignment and immobilization must be followed. The attendant must take extra care to prevent the complications of spinal-cord injury. By thinking ahead, the attendant will also avoid unnecessary movement of the patient and ensure maximum patient comfort and safety.

Part 7

Facial Trauma

Part 7 **Facial Trauma**

Facial injuries and their management

For a variety of reasons, the face is particularly prone to injury. Soft-tissue injuries and fractures to the face are common. Facial injuries can be life threatening because of the possibility of airway obstruction. Furthermore, facial injuries can be very dramatic and may divert the attendant's attention away from more serious injuries that are not as obvious.

Anatomy and function

The key bones of the face are the mandible (lower jaw), the maxilla (upper jaw), the zygoma (cheek bone), the nasal bones, and the bones of the orbits (around the eye sockets). The sinuses are small cavities contained within some of the facial bones. The sinuses drain into the nasal cavity. The most important organs of the face are the eyes, which are protected by the bones of the orbit. The skin and muscles of the face are richly supplied with blood vessels. This explains the profuse bleeding that usually occurs with open facial wounds.

Assessment and treatment of facial injuries

The assessment and management of patients with facial injuries should follow the priority action approach to the injured patient (see page 18) and the Assessment and Management of the Patient with a Head Injury, as outlined on page 129.

The attendant's first priority is to clear the airway. Several factors associated with facial injuries may cause airway obstruction:

- Bleeding within the oral cavity or from the nose
- Vomiting
- Loose teeth or dentures
- Fractures of the mandible and/or maxilla producing significant deformity of the airway
- Swelling of the soft tissues, which encroaches on the airway
- Direct injury to the anterior neck (e.g., voice box or trachea)
- Brain injury causing a decreased level of consciousness

Due to the mechanism of injury, facial injuries are often associated with cervical spine fractures. The attendant must suspect a cervical spine injury in all patients with facial injuries. If the patient is fully conscious, a cervical spine injury may be ruled out under the criteria listed in Figure 3-11 Modified Nexus flow chart on page 41.

Facial injuries are also associated with brain injury. In conscious patients, the attendant must determine if the patient suffered a loss of consciousness. All patients with facial injury who are dazed, are confused, have memory loss, or have experienced a decreased level of consciousness require referral for medical evaluation.

Soft-tissue facial injuries

The evaluation and management of the worker with facial injuries follows the priority action approach outlined on page 18 or the priority action approach to the Walk-In Patient outlined on page 193.

Bleeding is best controlled by direct pressure. Through-and-through lacerations involving the lip or cheek usually require pressure from both sides to control the bleeding. The attendant must wear Nitrile or similar gloves before putting their fingers into the patient's mouth.

Facial lacerations often require suture repair to ensure a good cosmetic result. The guidelines indicating which lacerations require physician referral are listed on page 214, Referral to Medical Aid. Wounds that require suturing are not medical emergencies in themselves. As long as the patient is referred to a physician within 6 hours of injury, a good result is usually assured.

Avulsed skin should be retrieved from the incident site if possible. It should be cleansed and packaged exactly as an amputated part (see page 222, Management of Severed Parts).

Flap-type soft-tissue injuries should be repositioned, cleansed, and bandaged in position. If the flap is left in a twisted or kinked position and then bandaged, the blood supply to the flap may be cut off. The flap may be permanently damaged and any subsequent attempt to repair the laceration will fail, leaving the patient with a permanent disfigurement.

Bleeding from a laceration of the tongue may be difficult to control with pressure. The attendant must ensure proper drainage to prevent the development of airway problems.

Nosebleeds usually result from blunt trauma and may be associated with nasal fractures. Patients with nosebleeds associated with suspected cervical spine injury must be treated with cervical spinal motion restriction in the lateral position.

Facial fractures

Fractures of the facial bones usually involve the nose, the orbit, the cheek bone (zygoma), the maxilla (upper jaw), or the mandible (lower jaw). Clues to the presence of fracture are swelling, deformity, and bleeding. Fractures of the maxilla or mandible may be suspected by irregularities of the patient's bite or an inability to open the mouth fully.

In all such injuries, especially those involving the maxilla and/or the mandible, the airway must be carefully assessed and cleared. These patients are at continuous risk of developing airway obstruction because of ongoing bleeding or swelling (see Figure 19-1 Facial fractures). All patients with suspected facial fractures must be assessed for the possibility of brain and/or cervical spine injury.

Fractures of the nose

Nasal fractures by themselves are not medical emergencies. In the presence of significant swelling, it is often difficult to assess the degree of deformity. These fractures may not be "straightened" by the physician for 4 to 7 days after injury, until the swelling has subsided. The attendant must ensure the airway remains clear, the bleeding is stopped, and the patient is referred to medical aid.

Fractures of the maxilla or mandible

The attendant must ensure that the airway remains patent. Patients with a fracture of the maxilla or mandible are best managed in the lateral position. The attendant should avoid supporting or wrapping the jaw with padding because the patient's airway may become blocked. The mouth must be kept open to ensure drainage of blood or vomitus.

Figure 19-1 Facial fractures

Fractures of the orbit or cheek bone

These fractures are often associated with eye injuries as well as with brain or cervical spine injuries.

Swelling is best controlled with ice packs. Bleeding is controlled with direct pressure, although the attendant must be careful not to apply pressure to the eyeball. The attendant should refer patients with either type of fracture for assessment by a physician.

Injuries to the throat and anterior neck

The region of the throat and anterior neck contains upper airway structures, the larynx (voice box), and the trachea as well as the carotid artery supplying the brain. Both open and blunt injuries to this region are potentially life threatening. Patients with open wounds of the neck, no matter how minor these appear, are in the rapid transport category. Examples of blunt injuries are direct impact from steering wheels in motor vehicle crashes, clothesline-type injuries sustained while riding a bicycle or running, and suicide attempts from hanging.

The attendant's immediate priority is stabilization of the airway. Clues to airway problems are swelling, hoarseness, stridor, or subcutaneous emphysema.

A cervical spine injury must be suspected with all injuries to the throat and neck, and the patient must be appropriately immobilized. See page 153. Penetrating or blunt trauma to the anterior neck is one of the few cases where a cervical collar should not be used to stabilize a suspected cervical spine injury. A collar would interfere with the continuous monitoring of the patient's injury and would not allow for swelling. The cervical spine must still be manually supported by the attendant to restrict movement of the cervical spine with the assistance of helpers, sandbags, or padding.

The patient should be managed in the position of maximum comfort. If a cervical spine injury is suspected, the patient is best managed in the supine or lateral position.

Bleeding may be controlled with direct pressure, but the attendant must take care not to compress the patient's airway (located in the midline). A circumferential dressing must not be applied around the neck. Open wounds must not be probed as doing so may worsen the injury. The remainder of the primary survey is completed, and the patient is rapidly transported to hospital.

Summary

Facial injuries are very common and potentially life threatening. By following the basic principles of the priority action approach and the general treatment principles for soft-tissue injuries, the attendant will be able to provide optimal care to these patients. Early recognition and effective treatment of airway problems are lifesaving. Appropriate treatment of soft-tissue injuries at the scene will minimize any permanent scarring or disfigurement.

Eye injuries

Eye injuries are very common in the workplace. They can result from a variety of workplace activities, including working with or near chemicals, laser and UV light, and/or flying particles from bursts of compressed air or other compressed gases or simply by windblown debris. The attendant must be able to assess the severity of eye injuries and apply appropriate treatment protocols.

This chapter provides an overview of common eye injuries and introduces the attendant to the principles of eye injury management.

Anatomy and function of the eye

The eye is an organ adapted for vision. It has many intricate parts; all of them important for the eye's proper function (see Figure 20-1 Anatomy of the eye).

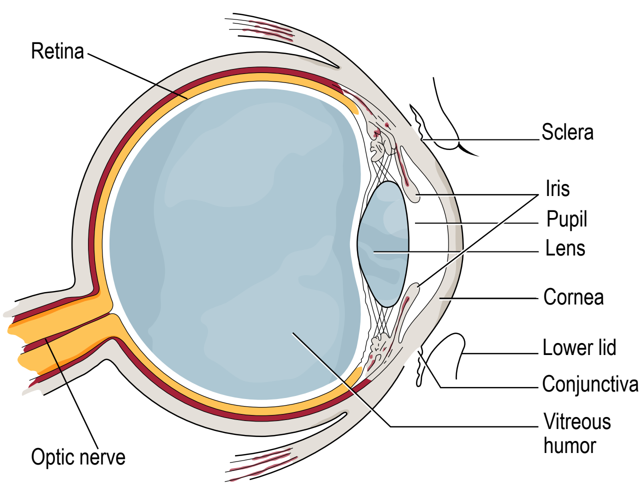

Figure 20-1 Anatomy of the eye

The eyeball is globe-shaped and about 2.5 cm (1 in.) in diameter. The shape is maintained by the fluid contained in the eyeball. The fluid is a clear, jelly-like substance called the vitreous humor.

The anterior wall of the globe is a clear, transparent window through which light enters the eye. It is called the cornea. The sclera (white part of the eye) is a tough tissue making up the outer wall of the rest of the globe. The sclera is covered by a layer of clear membrane called conjunctiva. This membrane also covers the inside of the eyelids. When the eyelids move, the two smooth subconjunctival surfaces slide over one another.

The coloured portion of the eye, the iris, is an adjustable circular muscle behind the cornea. It has an opening, like that of a camera, which regulates the amount of light entering the eye. The opening in the iris is the pupil. Behind the iris is a lens that focuses an image on the retina, a light, sensitive layer of cells at the back of the eye. The retina changes the light image into electrical impulses, which are carried by the optic nerve to the brain. The pressure of the vitreous humor supports the retina.

The lacrimal system is composed of lacrimal — tear — glands and ducts (see Figure 20-2 Lacrimal apparatus). Tears produced by the lacrimal glands protect, clean, and lubricate the eye. The tear glands are located beneath the upper eyelid. The tear ducts are on the inner side of the eye, along the upper and lower lid.

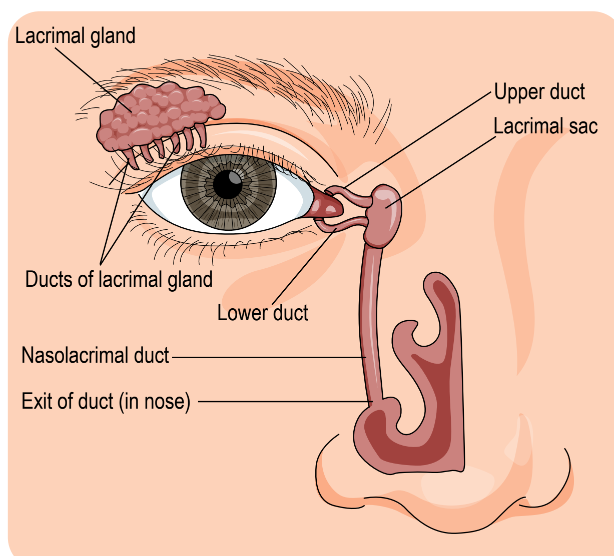

Figure 20-2 Lacrimal apparatus

Upper and lower eyelids protect the eyes. The smooth subconjunctival lining of the eyelids is kept moistened by tears. The upper eyelids glide up and down over the eyes to protect them from dust and other irritants. The eyelids are closed by the contraction of a circular muscle around each eye.

The pupil of the eye constricts or dilates as it adjusts to various degrees of light. The pupil also adjusts when a person is viewing close or distant objects. Pupil adjustment is automatic and almost instantaneous.

Normally, when a light is directed into the eyes, the pupils constrict — become smaller. When in darkness, as the eye is shaded or the lids closed, the pupils dilate — become larger. The size of the pupils, any difference in size between the two pupils, and their reaction to light are important signs that may help determine the nature and severity of a head injury.

Types of eye injuries and their management

A relatively minor eye injury can cause very serious, lasting consequences if it is not treated correctly. Proper initial care of an eye injury not only relieves pain but can also help prevent permanent loss of sight.

The main types of eye injuries are caused by:

- direct blows from sharp or blunt objects — lacerations, contusions, extruded eyeball
- burns — chemical, thermal, radiation
- foreign bodies — penetrating, superficial

Lacerations

A laceration to the eye can involve the eyelid, the eyeball, or both.

The evaluation and management of the worker with eye injuries follows the priority action approach outlined on page 18 or the priority action approach to the Walk-In Patient outlined on page 193.

If there is suspicion of a penetrating injury to the eyeball — the globe — do not apply any pressure to the eye. This could force fluid out of the eyeball and cause permanent damage

Eyelid lacerations usually bleed profusely because the eyelids have a rich blood supply. Bleeding can be controlled by gentle direct pressure. The patient with lacerations to the eye, with any possibility of perforation, must have the affected eye protected by a rigid eye patch. No pressure of any kind should be placed on the eye. If a rigid eye patch is not available, a paper cup can be cut down to cover the affected eye and taped in place.

A torn eyelid may be flushed to remove dirt. The flushing solution should be restricted to normal saline or drinking water. Then apply a moist gauze dressing. Be sure to send any avulsed — detached — tissue, also wrapped in moist gauze, to the hospital with the patient (see page 222, Management of Severed Parts).

The patient with lacerations of the eye or suspected penetrating eyeball injury must be transported face up on a stretcher, with their head elevated and secured adequately enough to restrict movement of the head and neck. Dress the eyes as above, protecting the affected eye from any pressure using padding and rigid protection, then bandage lightly. For comfort, both eyes should be loosely covered because the eyes move in tandem, and this prevents the patient from moving the injured eye.

Contusions

Blunt trauma to the eye can cause bleeding within the eyeball, which is known as a hyphema. More superficial bleeding — where the bleeding is within the walls of the eye but not into the vitreous — is known as subconjunctival hemorrhage.

Hyphema

With hyphema, blood may be seen overlying the iris or pupil.

For transport to the hospital, take the following precautions:

- Keep the patient still, with both of their eyes covered.
- Keep the patient in the sitting position, other injuries permitting, to allow the blood to collect in the bottom of the eye.

Subconjunctival hemorrhage

A subconjunctival hemorrhage is actually a bruise of the transparent conjunctiva or underlying sclera. It is seen as a very obvious, bright red colour overlying the white part of the eye (the sclera). Such injuries are commonly seen but are not serious unless associated with a laceration or penetrating injury to the eyeball. Subconjunctival hemorrhage requires no treatment and generally resolves spontaneously within a few days.

Extruded eyeball

An extruded eyeball is an eye that has been torn from its socket.

The evaluation and management of the worker with an extruded eyeball follows the priority action approach outlined on page 18.

- An extruded eyeball should never be pushed back into place.
- Both eyes should be covered with sterile dressings, and the dressings over the injured eye should be moistened with sterile saline.
- The injured eye must be protected from any pressure by use of padding, rigid protection, and bandaged lightly (see Figure 20-3 Eyeball supported).
- The patient must be transported supine, with their head comfortably restricted from movement.

Figure 20-3 Eyeball supported

Chemical Burns

With chemical burns, the severity of damage to the eye varies depending on the properties and concentration of the chemical and the duration of exposure (see Figure 20-4 Chemical spill to eye).

Damage from alkalis

Strong alkalis produce the worst injuries, because of how rapidly they penetrate into tissue cells. Widespread cell death can be reduced by immediate dilution with water of the alkali in the eye. An eye can look normal for several hours after a blinding alkali burn.

Common alkalis are caustic soda (e.g., sodium hydroxide) lye, drain cleaners, cleaning agents, ammonia, cement, and plaster.

Damage from acids

Acids cause more visible immediate damage to the eye, but penetrate less deeply. They are more easily washed out; if they are washed out immediately with water, serious injury can be reduced.

Common acids are sulphuric (battery) acid, hydrochloric acid, nitric acid, and acetic acid.

Management of chemical burns to the eye

The evaluation and management of the worker with chemical eye burns follows the priority action approach outlined on page 18 or the priority action approach to the Walk-In Patient outlined on page 193.

Wherever chemical burns are possible, an eyewash station should be immediately available. Personnel at risk should be taught the fastest method of washing a contaminated eye.

Figure 20-4 Chemical spill to eye

The attendant should take the following steps when caring for a patient with chemical burns to the eye:

1. Irrigate the patient's eyes for a minimum of 30 minutes by the clock (see Figures 20-5 and 20-6 Flushing the eyes). Use tempered, running tap water or, preferably, normal saline to continuously flush the eye. Chemical neutralizing agents may not be practical and may cause more damage. Care must be taken when considering using an eyewash solution other than water. Water is

readily available and is generally much more suitable for eye irrigation. Commercially available, isotonic eyewash solutions are acceptable providing they have the same acidity/alkalinity rating as water — pH7.

2. Conduct the primary survey and necessary components of the secondary survey (see page 33, Secondary Survey). It may be possible to accomplish this simultaneously with the flushing.
3. Examine the eye and remove remaining particles of chemical from behind the eyelids with a moist gauze pad or cotton-tipped applicator (see page 169, Management of Superficial Foreign Bodies).
4. If the patient's eyes were burned by strong alkalis or acids, continue to flush them while en route to medical aid if possible. If available, use sterile normal saline from an IV bag. The IV tubing can be held at the inner corner of the eye. Saline is allowed to run across the eye and out of the outer corner. If saline is not available, tap water will suffice.
5. If continuous flushing is not possible, use cold wet dressings — changed frequently — on the patient's eyes and other affected areas during transport.

Figure 20-5 Flushing the eyes

Figure 20-6 Flushing the eyes

Thermal burns

With exposure to heat, the eyelids rapidly close, usually protecting the eyes from damage. However, the eyelids themselves are frequently burned. The treatment of burned eyelids requires specialized medical care.

Management of thermal burns

The evaluation and management of the worker with thermal eye burns follows the priority action approach outlined on page 18 or the Priority Action Approach to the Walk-In Patient outlined on page 193. The attendant should also keep in mind the following points:

- Do not examine the eye as this may injure the burned tissue.
- Both eyes should be covered with moistened sterile dressings.
- Transport to medical aid.
- Do not apply any home remedies or burn ointments.

Ultraviolet Radiation Injuries

Direct or reflected ultraviolet light from an electric arc or welding torch may cause a surface burn to the cornea, called flash burn. Corneal burns become more painful after some hours. Although flash burns are very uncomfortable, they are not serious and usually heal in 12 to 24 hours.

Management of flash burn

The evaluation and management of the worker with flash burn follows the priority action approach to the Walk-In Patient outlined on page 193.

- Examine the eyes (see page 169, Management of Superficial Foreign Bodies) to rule out the presence of any foreign bodies.
- Cold compresses and mild pain medications — ASA or acetaminophen — may help the patient to sleep at night.
- A patient with severe ultraviolet burns may be unable to return to work for one to two days.
- The patient may need to wear dark glasses for a couple of days due to the eye's increased photosensitivity — light sensitivity.

Use and abuse of topical anaesthetics

With ultraviolet flash burns, the use of topical anaesthetic drops by the attendant will facilitate proper eye examination. Topical anaesthetics are usually available by prescription, and must be used only as per the ordering physician's instructions (see page 199, Prescription Drugs and Medications). They may be put in the patient's eyes initially, and may be reapplied once, if required, to ensure a good eye exam. Any further administration requires a physician order. Although the anaesthetic drops make the patient feel better, they can impede healing of the injury.

Topical anaesthetics (e.g., amethocaine drops) are best supplied in droplet form from individual-use dispensers. Do not use local anaesthetic ointments. Caution: Topical anaesthetics must never be given to the patient for self-administration.

Topical anaesthetics provide instant relief but can also cause problems:

- Topical anaesthetics are mildly acidic and prevent tissue healing.
- An anaesthetized eye can be further injured due to the loss of normal protective reflexes — e.g., a foreign body would not be felt and could cause further damage without being noticed by the patient.
- A worker must not return to work or drive a vehicle for at least one hour after the application of a local anaesthetic. By this time, eye sensitivity will have returned.

Foreign bodies

Foreign bodies in the eye may be divided into two groups:

- Penetrating — These are usually small, high-velocity foreign bodies. They are sharp enough or have enough velocity to penetrate the eye.
- Superficial — These are objects such as eyelashes, welding slag, and dirt particles. Some are easily removed from the eye, and some may be stuck to the eye surface or the underside of the eyelids, most commonly the upper eyelid.

Management of penetrating foreign bodies

Penetrating wounds of the eye are very serious (see Figure 20-7 Penetrating eye injury). A metallic projectile may penetrate the eyeball causing little or no pain. The wound may not be noticed on routine examination. The attendant must suspect a penetrating injury with high-velocity incidents such as hammering — especially metal on metal — grinding, chiselling, or explosions.

Figure 20-7 Penetrating eye injury

The evaluation and management of the worker with a penetrating eye injury follows the priority action approach outlined on page 18 or the priority action approach to the Walk-In Patient outlined on page 193.

1. Obtain a history.
2. Immediately lay the patient supine and support their head to restrict movement.
3. If the history suggests a penetrating eye injury, the patient is in the rapid transport category.
4. Do not attempt to wash out the eye. Do not remove foreign bodies that impale or protrude from the eye or eyelid. They should be removed only by a physician.

5. If the injury makes it impossible to close the eye, use a dressing moistened with sterile saline to cover the injured eye.
6. An eyeball with a suspected penetrating injury should be protected with a rigid eye patch. Use padding to ensure support for any protruding object, taking care not to put any pressure on the eyeball (see Figure 20-8 Use padding to ensure support).
7. Transport the patient lying down with their head slightly elevated and movement of the patient's head comfortably restricted.

Figure 20-8 Use padding to ensure support

Management of superficial foreign bodies

Most foreign bodies in the eye are superficial and are easily removed without any complications.

The evaluation and management of the worker with a superficial foreign body in the eye follows the Priority Action Approach to the Walk-In Patient outlined on page 193.

1. Tell the patient not to rub the eye.
2. Obtain a history. Suspect a penetrating injury with high-velocity incidents such as hammering — especially metal on metal — grinding, chiselling, or explosions, and treat the patient accordingly. Obtain information concerning the accident:
    - Time and location
    - Details of injury — e.g., blow, foreign material, sharp object
    - Nature of the foreign material — e.g., acid, alkali, steel, glass, fume
3. Position the patient and wash your hands thoroughly.
4. Wipe away any dust or foreign material from the patient's face.
5. With a history of a low-velocity foreign body, attempt to remove the object by flushing the eye prior to examining it. Use an eye cup filled with clean water or saline. Have the patient bend forward and make a seal between the rim of the eye cup and their eye socket, then tip the head back and blink several times. Instruct the patient to then tip their head forward with the eye open and remove the eye cup. A clean cupped hand and clean tap water can be used in an emergency.
6. Some non-sharp foreign bodies can be dislodged by manipulating the eyelid. For example, a foreign body under the upper eyelid can be dislodged by having the patient hold their upper eyelashes and gently pulling the eyelid down over the lower lid. The eyelashes from the lower eyelid will brush the inside of the upper eyelid. Do not have the patient do this more than twice. Do not use this procedure if the patient is wearing mascara on the lower eyelashes.
7. If the preceding steps do not remove the foreign body or the patient still complains of discomfort in the eye, an eye examination must be conducted

General eye examination

1. Assess the patient's vision in the affected eye so that any differences in vision will be apparent when the patient's vision is assessed after the object is removed. Use the following techniques to assess the patient's vision:
    - Check whether the patient can see light.
    - Check whether the patient can count fingers.
    - Ask the patient to read, using corrective lenses if these are normally worn.
2. Examine the patient's eye for foreign objects:
    - Ensure that the patient is comfortably seated or lying down, with their head well back and firmly supported.
    - Position yourself in front of and slightly above the patient and have the examining room light as bright as possible. Patients with eye injuries are often very light sensitive, and a better examination may be obtained with room light than with a direct penlight beam.

- If you wear gloves, they must be the unpowdered type so the powder does not get into the patient's eye.
- Always use great care and gentleness. The hand holding any instrument used near the eye must be steadied on the patient's cheek or forehead.
- Magnification devices can be used to help discover the object.
- With the eyelids well separated, carefully inspect the inner and outer canthus — corners and the folds of the conjunctiva of the lower lid (see Figure 20-9 Inspect corners of the eye). This is where many foreign bodies will be carried due to gravity.
- Gently pull down the lower lid and have patient look up to expose the lower conjunctiva and the inside of the lower lid.
- Gently pull up the upper lid and have the patient look down to expose the upper conjunctiva. With the eyelids well separated, have the patient slowly move their eyes to the left and right, then up and down. A penlight can be used to shine a light from the side of the eye to see if the object will cast a shadow. Move the penlight to the left and right and then up and down.
- Look for any sign of scleral injury, inflammation, hemorrhage, or congestion of the subconjunctival tissue and for any foreign body.
- Most foreign bodies can be removed with a moist gauze pad or cotton-tipped applicator. Place the corner of the gauze or tip of the applicator gently on the foreign body. Give the gauze or applicator a very gentle slight twist or short wipe to pick up the foreign body. Only one such attempt should be made to remove a foreign body.
- If the foreign body is adhering to the eye, refer the patient to a physician (see page 172, Referral to Medical Aid).
- The position of the foreign body can be described by the clock method (see Figure 20-10 Clock method of reporting foreign body location).

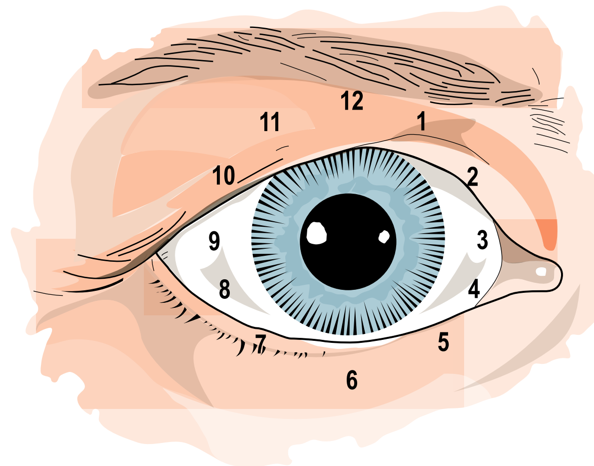

Figure 20-10 Clock method of reporting foreign body location

3. Examine the cornea.
   - With the patient looking straight ahead, shine a penlight at the cornea from an angle.
   - Look for foreign bodies, dark spots, or irregularities on the clear corneal surface as the light moves. The room lights may need to be dimmed.
   - Look for any clouding of the cornea; normally it is clear.
4. Examine the anterior chamber — the space immediately underlying the cornea but in front of the iris — and iris using a penlight.
   - Anterior chamber — Look for any blood or foreign body. Blood may be best seen when the patient is seated.
   - Iris — Look for any irregularity or a tear.
5. Examine the pupil.
   - Pupil size — Are the pupils equal in size? Check this in dim light.
   - Pupil shape — Are both pupils round? Normal? Or irregular? An irregular-shaped pupil is a dangerous sign.
   - Pupillary response to light — Light reflex. With a penlight and in a dimly lit room, examine the pupils for their response to bright light:
     a. Shine the light into each eye. Watch for rapid pupillary constriction in that eye.

b. Repeat the procedure watching for rapid constriction in the opposite eye. Slow or absent constriction is abnormal. A patient with this response must be referred to a physician for further assessment.

6. If a foreign body is not found and/or the patient still feels discomfort in the upper area of the eye, examine the underside of the upper eyelid — called everting the eyelid. Do not evert the upper eyelid if a penetrating injury is suspected — e.g., an injury where the outer eye has been pierced; patients with this injury are in the rapid transport category. To evert the upper eyelid, follow these steps:
   a. Hold the top lashes firmly between your thumb and first finger.
   b. Instruct the patient to look down.
   c. Place a cotton-tipped applicator against the outside and about halfway down the eyelid (see Figure 20-11 Place cotton-tipped applicator on eyelid).
   d. Pull the eyelid out and up over the applicator and hold the eyelid everted (see Figure 20-12 Evert and hold lid).
   e. Remove the object, if any, and allow the eyelid to return to its normal position.
7. Examine the patient's eye movements. Have the patient watch an object or a light as it moves in all directions of gaze — i.e., to the right, left, up and down, following an H pattern. Look for a failure of either eye to follow the object, and ask the patient if they feel any pain or has double vision.
8. Reassess the patient's vision as outlined in step 8 above, noting any differences from the earlier assessment.

Figure 20-11 Place cotton-tipped applicator on eyelid

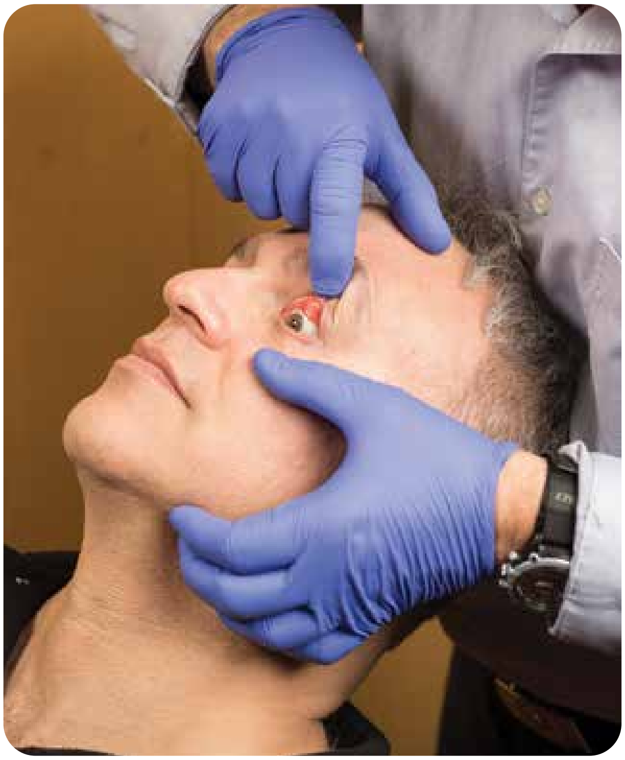

Figure 20-12 Evert and hold lid

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Referral to medical aid

For a foreign body that cannot be removed by the previously discussed methods, cover the patient's eye and refer them to a physician. Because depth perception is impaired with one eye patched, such a patient should not be allowed to drive a motor vehicle.

Even after the successful removal of a foreign body, the patient may still complain of a foreign-body sensation. This usually indicates a corneal abrasion. Cover the patient's eye and refer them to a physician.

A rust ring may also develop on the cornea after the foreign body has been removed. This occurs when any foreign body containing iron is not removed for several hours. Once the foreign body is removed, a small round ring remains. Depending on its location on the cornea, it may need to be removed by a physician. This is not an emergency; in fact if the metallic foreign body has been removed, it is best to remove the rust ring one to two days later.

Emergency procedures for contact lens removal

Types of contact lenses

- Hard — plastic discs, non-flexible
- Soft — plastic discs, flexible

Removal of contact lenses

Ask the worker if they are wearing contact lenses and, if so, what type. Have the patient remove the lenses, if possible. If the patient cannot remove the lenses, the attendant may assist using the following techniques.

Hard lens removal

1. With clean hands, gently separate the eyelids so they are clear of the bottom and top of the lens.
2. Move the eyelids together close to the edge of the contact lens, pressing slightly harder on the lower eyelid while sliding it upward.
3. When the lens pops over the lower eyelid, move the eyelids further together so that the lens slides out between them.
4. Store the lenses in water in separate containers, marked "left" and "right."

Soft lens removal

1. With clean hands, gently separate the eyelids. Pull the lower eyelid down with the middle finger. Place the index finger on the lower edge of the lens. Slide the lens down onto the white part of the eye. If the lens does not move easily, flush the eye with normal saline and repeat the procedure. Do not remove the lens while it is over the coloured part of the eye (the iris).
2. When the lens is pulled down, pinch it lightly between the thumb and index finger and remove it from the eye.
3. Store the lenses in water in separate containers, marked "left" and "right."

If a patient is known to be wearing contact lenses and they have not been removed, place adhesive tape marked "contact lenses" on the patient's forehead.

Dental injuries

Dental injuries can occur in various ways. Sometimes they are isolated injuries, but usually they occur in association with other injuries, such as a jaw fracture. Often, bleeding may obscure an underlying dental injury. The attendant should look or gently feel in the patient's mouth, when practical. Dental appliances, such as bridges, crowns, and dentures may be involved. These may also be fractured, possibly adding to the soft-tissue injury. The basic anatomy of a tooth is illustrated in Figure 21-1.

Loss of a tooth

The loss of a tooth is an avulsion wound. The evaluation and management of the worker who has lost a tooth follows the priority action approach to the Walk-In Patient outlined on page 193. Specific treatment is as follows:

- Stop bleeding from the gums with local pressure.
- When possible, locate the missing tooth at the incident scene.
- Wash the tooth gently in saline or water.
- Do not rub the tooth excessively. Try to hold the tooth from the outside edge, not the inner root.
- Ideally, the tooth should be placed in "Hank's balanced salt solution" or Save-A-Tooth. If that is not available, then egg white, coconut water, or whole milk are easily obtained substitutes.
- Be sure to send the tooth with the patient when they are transported. Avulsed teeth can sometimes be re-implanted. Ideally, this should be done within a half hour. After 24 hours, the success rate is poor.
- If the patient is conscious and considerable time may pass before a dentist is available, the attendant may try to re-implant the tooth. After cleaning, gently but firmly reinsert the tooth into its socket. The patient may stabilize it with very light pressure on a piece of gauze placed between the jaws. Instruct the patient not to bite down hard on it until a dentist has been consulted.

Loose tooth

- If a tooth is loose, but not actually displaced, refer the patient to a dentist.
- If the tooth is loose and displaced more than 2 mm, gently push it back into its normal position if it will go easily. Refer the patient to a dentist.

Crowns, bridges, plates, and other dental appliances

- Where a fractured dental appliance remains in the mouth following injury, gently remove it to prevent further injury. Do not use force.
- Refer the patient to a dentist.

Tooth fractures

These may be very painful and require early referral to a dentist for pain relief.

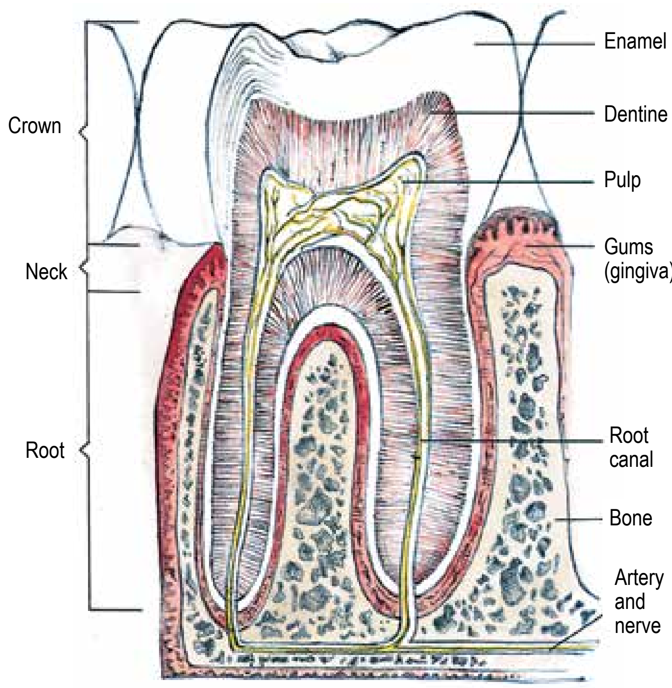

Figure 21-1 Basic anatomy of a tooth

Ear injuries

The ear is a commonly injured sensory organ. Ear injuries are often associated with serious head injuries. Correct management of ear injuries in the early stages can prevent both long-term hearing impairment and cosmetic consequences.

Anatomy of the ear

The ear can be divided into three distinct anatomical parts: the external ear, the middle ear, and the inner ear (see Figure 22-1 Anatomy of the ear).

The External Ear

The external ear is composed of skin and cartilage (the pinna or auricle) and the external auditory meatus. Its purpose is to trap sound waves and direct them down the ear canal to the eardrum, which is part of the middle ear.

The Middle ear

The middle ear is made up of the tympanic membrane (eardrum) a small air-filled cavitybehind the eardrum, and three tiny bones, the malleus, the incus, and the stapes — collectively these bones are called ossicles. The middle ear connects the external ear to the nerve centre in the inner ear.

The Inner ear

The inner ear is composed of two parts:

- Cochlea — responsible for interpretation of sound
- Vestibular apparatus — responsible for balance

The External ear

Foreign bodies

It is imperative to have full co-operation from the patient with a foreign body in their ear. It is likely that the attendant will cause significant injury to the eardrum and underlying structures if the patient is struggling.

Objects such as insects, dirt, sawdust, and slag from welding metal can usually be removed by flushing the ear with warm water or mineral oil. Larger objects, such as pebbles, are best removed by a physician. If there is any bleeding, severe pain in association with a foreign body in the ear, or hearing loss, the attendant should only cover the ear with a sterile dressing and refer the patient to a physician.

Where the ear canal or the eardrum has been burned (such as with hot slag), the patient must be referred to a physician.

Lacerations/avulsions

If the external ear is torn or torn off, the evaluation and management of the patient follows the priority action approach to the Walk-In Patient outlined on page 193.

- Control bleeding by direct pressure.
- Position the external ear as close as possible to its normal anatomical position, checking carefully for any tissue loss.
- Cleanse the wound as necessary (see page 214, Wound Cleansing).
- Dress and bandage the wound (see page 215, Dressing and Bandaging of Open Wounds). Place a sterile gauze dressing both behind and over the ear.
- Retrieve and preserve any avulsed parts, and send these with the patient to a physician (see page 222, Management of Severed Parts).

Hematoma

Significant bruising or hematoma formation in the external ear can produce permanent disfigurement (e.g., “cauliflower ear”). The attendant should intermittently apply ice packs locally to minimize further swelling and bruising, and refer the patient to a physician.

Infection

Permanent disfigurement is much more likely if infection occurs following either blunt trauma or a laceration to the external ear. Again, the attendant should refer the patient to a physician.

Ear injuries associated with skull fractures

Fractures of the skull that extend into the ear canal — basilar skull fractures — are always potentially dangerous because of the risk of introducing infection into the middle or inner ear, or even into the brain. Any handling or cleansing of the ear should be restricted to the removal of gross dirt or blood clots while ensuring that no fluid is allowed to enter the ear canal.

Any clear fluid seen dripping from the ear following blunt head injury is cerebrospinal fluid (CSF). This indicates a serious (See Figure 16-1 Signs of a basilar skull fracture) and increases the risk of meningitis. In the absence of direct ear trauma, blood coming from the ear canal may also indicate a basilar skull fracture.

Patients with either clear fluid or blood coming out of their ear should have a sterile dressing applied to the ear and must be transported to a hospital (see page 129, Assessment and Management of the Patient with a Head Injury).

The middle ear

Injuries

Perforation of the eardrum often occurs with blast, decompression, or penetrating injuries to the ear, or in association with head injuries. Depending on the nature and severity of the injury, the deeper structures of the ear can also be damaged to varying degrees, sometimes resulting in permanent hearing impairment and/or dizziness.

The evaluation and management of such patients follows the Priority Action Approach outlined on page 18.

Infection

Permanent disfigurement is much more likely if infection occurs following either blunt trauma or a laceration to the external ear. Again, the attendant should refer the patient to a physician.

The inner ear

The inner ear is most commonly damaged by loud noises. Damage can occur with brief exposure to very loud sounds or with chronic exposure to lesser noise levels. This is called "noise-induced hearing loss."

Blunt trauma to the head may result in disturbance of the inner ear's balance mechanism, which will cause dizziness and sometimes vomiting. Inflammation of the inner ear may also cause dizziness.

Injury suggesting middle or inner ear injury should be referred to a physician.

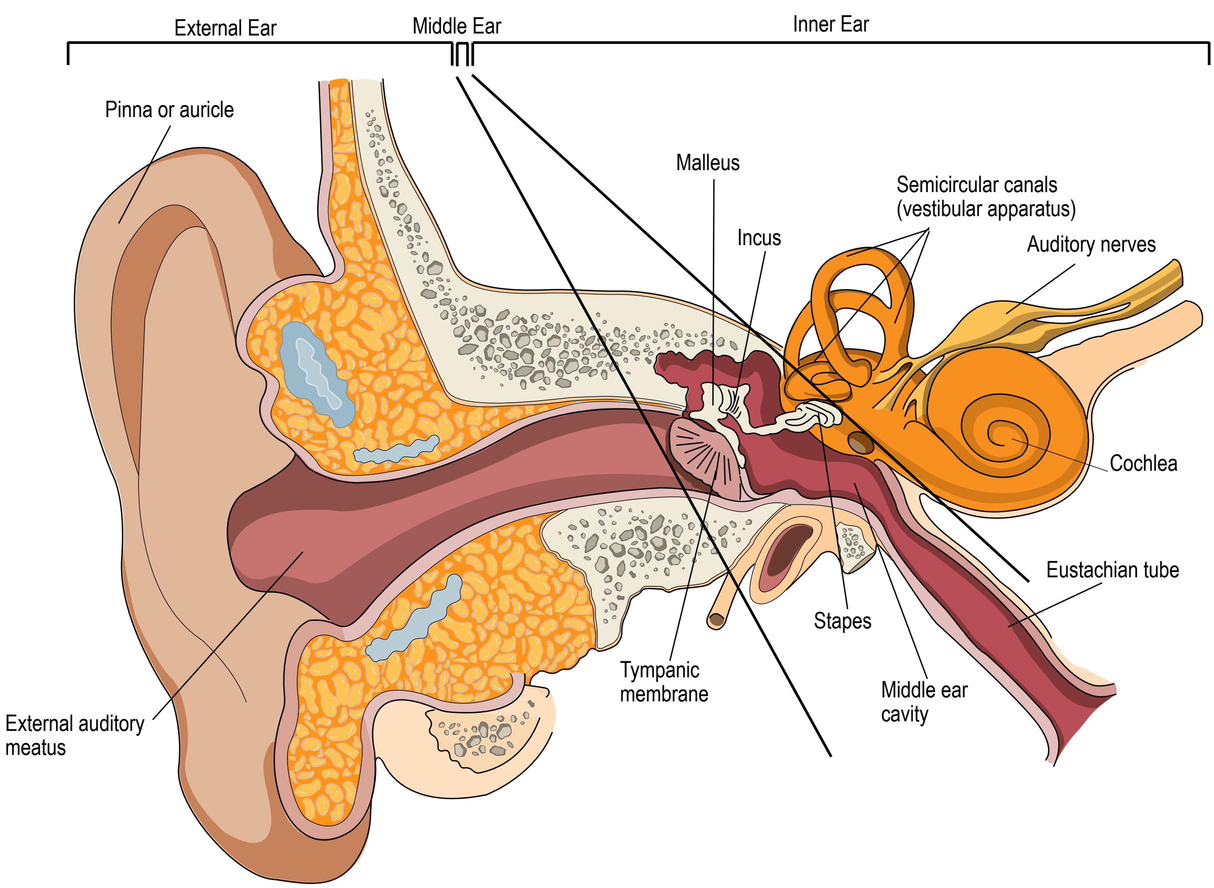

Figure 22-1 Anatomy of the ear

Part 8

Abdominal and Genitourinary Injuries

Part 8 Abdominal and Genitourinary Injuries

Abdominal injuries

The abdominal cavity contains most of the digestive organs, the liver, the spleen, and the female reproductive organs. The pancreas, kidneys, urinary bladder, ureters, parts of the large intestine, and the major blood vessels are all located posterior to the abdominal cavity, behind the peritoneum. These organs are embedded in the soft tissue of the back, flanks, and pelvis. The liver, spleen, and pancreas are considered solid organs, whereas the stomach, intestines, gallbladder, ureters, and urinary bladder are hollow organs.

The anatomy and function of the abdominal organs

The abdominal cavity is located inferior to the thoracic cavity — these are the two major cavities in the body. It is bounded above by the diaphragm and below by the pelvic bones (see Figure 23-1 Organs of the abdominal cavity).

The abdominal cavity is lined by a smooth, glistening membrane called the peritoneum. The peritoneum has two layers, similar to the pleura that line the thorax. One layer lines the wall of the cavity and another layer covers the organs.

The function of the peritoneum is to allow the organs to move by sliding against each other.

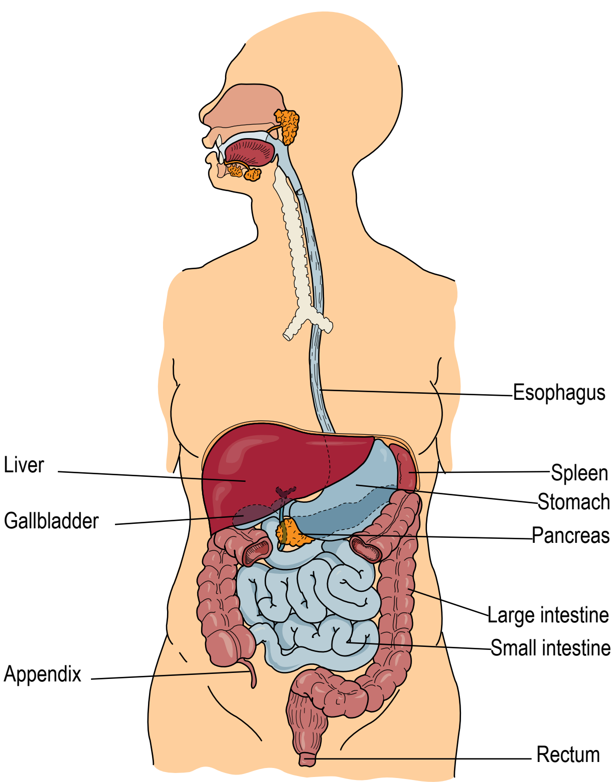

Figure 23-1 Organs of the abdominal cavity

Digestive system

All food must be in a suitable form before nutrients can pass through the wall of the bowel and actually enter the body. Digestion is the chemical process by which food is changed and made usable by the body. Once the food is digested, it is transferred to the bloodstream by absorption. Digestion and absorption are the two main functions of the digestive system.

The digestive tract begins at the mouth. It is a long tube, coiled in the abdomen and terminating at the anus, where the solid waste products of digestion are expelled from the body. Beginning at the mouth, the tract consists of the pharynx, esophagus, stomach, small intestine, and large intestine.

The breakdown of food begins in the mouth, where it is chewed by the combined action of the tongue and teeth. Salivary glands deliver their secretions (saliva) to the mouth, to help with chewing, swallowing, and digestion.

Swallowed food passes down the esophagus into the stomach. The stomach mixes and churns the food with gastric juices, enabling further digestion. The food is next moved into and through the small intestine by muscular contractions — peristalsis.

Absorption takes place in the small intestine. When the food enters the small intestine, additional digestive juices are supplied by the liver (bile), pancreas (pancreatic juice), and intestinal glands. These convert the food into basic sugars, fatty acids, proteins, water, and salt.

The basic food products are transported by the blood to the liver, where they are changed to substances that nourish individual tissues and cells. These substances are then transported in the blood through the circulatory system to all body cells.

Once the processes of digestion and absorption have been completed, the remaining substances are expelled. The large intestine contains layers of involuntary muscle, whose contractions move the solid waste products, called fecal matter, toward the rectum. Absorption of water also takes place through the walls of the large intestine.

Solid organs of the abdomen and their function

Liver

Liver functions include:

- Production of bile
- Breakdown and elimination of many drugs and poisons
- Storage of proteins, fats, minerals, and vitamins
- Storage and secretion of glucose — a simple sugar
- Production of many body proteins and clotting factors

Pancreas

Pancreatic functions include:

- Manufacture and release of insulin into the bloodstream, which regulates the amount of sugar used in the tissues
- Production of pancreatic juice, which aids digestion

Spleen

The spleen is also in the abdominal cavity. It is not associated with the digestive system, but instead has functions related to the circulatory and lymphatic systems, including:

- Destruction of old red blood cells
- Manufacture of some white cells
- Removal of potentially infectious matter from the blood

Kidneys

The kidneys are part of the urinary system (see page 185, Urinary System). The kidneys' three main functions are to:

- Extract wastes from the blood and excrete them as urine
- Aid in maintaining water balance
- Aid in regulating acid-base balance

Hollow organs of the abdomen and their functions

Stomach

The stomach's main function is to convert food into a semi-liquid mass, through muscular movements and gastric juices.

Small intestine

The main function of the small intestine is absorption of nutrients.

Large intestine

The main function of the large intestine is absorption of water and excretion of waste products.

Gallbladder

The gallbladder's main function is to concentrate and store bile, produced by the liver, which is used in the digestion of fats.

Ureters

The ureters are two tubes that pass urine from the kidneys to the urinary bladder.

Urinary bladder

The urinary bladder stores urine, excreted by the kidneys, until voided.

Urethra

The urethra is a tube leading from the urinary bladder to the exterior of the body. Urine passes through this tube to the exterior — referred to as voiding.

Abdominal injuries

Often, injury within the abdomen (intra-abdominal injury) may not be evident when the patient is initially examined. If the patient has obvious signs of shock in association with abdominal trauma, internal bleeding must be suspected. Such cases are in the rapid transport category. For the most part, a high degree of suspicion is required if abdominal injuries are to be diagnosed and receive proper treatment. Injuries to the abdominal contents should be suspected on the basis of:

- The mechanism of injury — e.g., a sudden deceleration, as with a free fall from a height or a motor vehicle accident
- The anatomy of the injury — e.g., a blow to the abdomen or to the lower chest wall
- The presence of abdominal pain
- The presence of bruises or abrasions on the abdominal wall or thorax
- Evidence of a penetrating wound to the abdominal wall or thorax
- During the head-to-toe examination, the attendant must carefully examine the abdomen and periodically re-evaluate the vital signs and injured areas to detect any new findings or deterioration in the patient's condition.

- The most important factor in the first aid treatment of abdominal trauma is not the diagnosis of a specific injury but determining that an intra-abdominal injury exists, then rapidly transporting the patient to hospital.
- All the solid abdominal organs are close to the diaphragm and protected by the ribs. The attendant should be aware of possible trauma to these underlying organs when the lower ribs are injured.
- Rupture or laceration of abdominal organs may cause severe bleeding. Patients with injuries to major blood vessels in the abdomen may bleed to death very quickly. Shock may be evident before peritoneal irritation becomes apparent. Hollow organs may be ruptured or lacerated and spill their contents into the peritoneal cavity. This will cause peritonitis, an inflammation of the peritoneum.
- The symptoms of advanced peritonitis are:
  - Severe abdominal pain, aggravated by any movement.
  - Protective muscle tightening (guarding) of abdominal muscles, which become more tense upon palpation. This may be localized at first, then spread until the whole abdomen is rigid.
  - Fever and a marked increase in abdominal girth (distension).
  - Dehydration, infection (sepsis) and, ultimately, septic shock in some cases.

Types of abdominal injuries

Abdominal wounds may be classified as either blunt or penetrating injuries, depending on whether the abdominal wall has been penetrated.

Blunt injuries

Blunt abdominal injury is caused by the direct transfer of energy to an organ, by compression of the abdominal organs against the spinal column, or by rapid deceleration, which may tear abdominal structures or their blood vessels (see Figure 23-2 Blunt abdominal trauma). Seat belts may contribute to abdominal injuries while preventing lethal head injuries. It must be emphasized that blunt trauma to the lower chest can produce injuries within the abdomen: for example, a fractured rib may rupture the spleen or pierce a kidney. Usually, the most significant immediate danger to patients with blunt abdominal trauma is serious hemorrhage. The initial examination of a patient with such injuries may reveal little. Based on the mechanism of injury where high-energy transfer has occurred, the attendant must maintain a high degree of suspicion, regularly re-evaluate the patient, and be prepared for the development of hypovolemic shock.

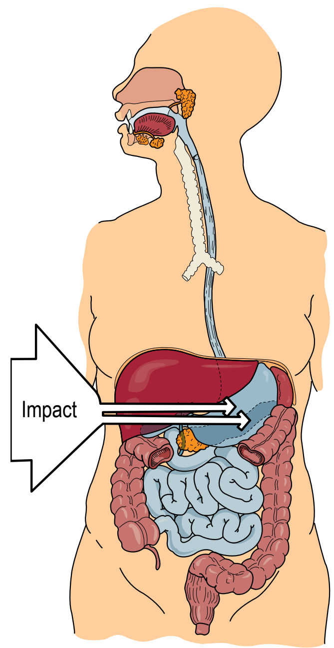

Figure 23-2 Blunt abdominal trauma

Penetrating injuries

Penetrating injuries are more obvious, but serious damage to internal organs is possible with little or no evidence of external injury. Penetrating wounds of the abdomen are more commonly caused by knives or gunshots but they can also be caused by shards of glass or sharp metal in an industrial accident. Penetrating abdominal injury usually results in:

- Bleeding from damage to a solid organ or major blood vessel
- Perforation of the small or large intestine

Severe bleeding will be evident early, with increasing abdominal distension, abdominal rigidity, and varying degrees of shock. The onset of abdominal pain may be delayed in the case of bowel perforation, which may also be life threatening.

If a person is impaled by a foreign object, the object must not be removed, because the patient may bleed to death. Injuries to the abdominal organs may occur with penetrating wounds of the lower chest, back, flanks, and buttocks.

A careful examination of the abdomen and the back is an important part of the secondary survey. The mechanism of injury should alert the attendant to the possibility of an abdominal injury.

General signs and symptoms of abdominal injury

The attendant must remember that non-penetrating or blunt injuries may leave little or no evidence of external injury.

Abdominal pain

The attendant should determine the location, intensity, time of onset, and duration of any abdominal pain and whether it radiates or not. Use the mnemonic P-P-Q-R-R-S-T. See page 38, Chief Complaints and History of Current Injury or Illness.

Visible soft tissue injury

Redness, bruising, abrasions, or an external wound will indicate the site of impact and will alert the attendant to internal injury.

Rigidity or guarding of abdominal muscles

Palpation may cause protective muscle tightening, or guarding, if the underlying peritoneum is irritated or inflamed.

Nausea and vomiting

The patient may vomit. The attendant must clear the patient's airway according to the protocols outlined in Airway Management, page 52. The attendant should also note the contents of the vomit — whether it contains undigested food or blood. The presence of blood at any body opening must be noted.

Shock

The signs and symptoms of shock may be present. Distension, restlessness, air hunger, and complaints of thirst may be the only indication that there is internal abdominal bleeding.

Abdominal distension

Internal bleeding or bowel perforation may cause abdominal distension. In the patient with a decreased level of consciousness, who cannot complain of abdominal pain, abdominal distension may be the only sign of internal abdominal injury.

External Abdominal Injuries

Any wound involving the abdominal wall must be considered as serious, regardless of the patient's condition at the time. The attendant should assume that major damage has been done even if there is no obvious sign of internal injury — e.g., the bowel may be perforated in several places. If these internal wounds are small, they may temporarily seal themselves and may not leak for several hours. The patient may feel fine during this time.

General principles of management for abdominal injuries

The evaluation and management of a patient with abdominal injuries follows the priority action approach outlined on page 18.

1. Conduct a scene assessment.
2. Position the patient supine, with C-spine control when the mechanism of injury suggests spinal trauma. If there is no concern for cervical injury, the patient may be positioned for comfort. The patient with abdominal injuries will often be found with their knees flexed to relieve pressureon the abdominal muscles. Maintain this flexion with padding.
3. Ensure an open airway.
4. Ensure adequate respiration.
5. Assess the radial pulse and the skin for signs of shock. If there is shock, maintain the patient in a horizontal position.
6. Control life-threatening bleeding (bleeding interventions may have been started earlier, as in The General Principles of Management of External Hemorrhage on page 105).
7. All patients with penetrating injuries to the abdomen or signs of shock are in the rapid transport category. Following the primary survey and initial management of life-threatening injuries, the patient must be transported rapidly to the nearest hospital. Maintain any flexion of the knees during transport (see Figure 23-3 Positioning for abdominal injury). Do not give the patient with abdominal injuries anything by mouth.

Figure 23-3 Positioning for abdominal injury

8. Reassess the ABCs every 5 minutes for RTC patients or every 10 minutes for non-RTC patients.
9. Conduct a secondary survey.

10. To determine if there is deterioration, monitor the vital signs every 10 minutes for RTC patients or every 30 minutes for non-RTC patients. For the urban attendant that has called for BCEHS resources to transport the patient, reassess the ABCs every 5 minutes and vitals every 10 minutes.

Protruding bowel

Once the primary and secondary surveys have been completed and the patient is en route to hospital or awaiting transport, the main points in caring for a protruding bowel are as follows:

- Gently cover the protruding bowel with several sterile gauze pads moistened with saline or water — sterile if available. If the intestine dries out, it may be permanently damaged.
- If a coil of intestine or an organ is protruding from the abdomen, support it with drainage dressings or other bulky dressings placed over the moistened sterile gauze to avoid unnecessary pressure on the blood vessels of the protruding part. Bandage the area securely enough to provide support and to keep the bowel clean, warm, and moist. Protection from further injury is sometimes accomplished by "corralling" the abdominal contents that are protruding. Padding may be used around the bowel protrusion; such padding should be thick, soft, and compressible. The attendant must use material that will not apply direct pressure to the bowel.
- If the treatment for protruding bowel contents is given in a cold environment, the application of fluid may not be advisable because of freezing. The application of sterile dressings and bandaging may have to suffice.

Do not delay the rapid transport of patients with protruding bowel to complete complicated dressings that can be done en route to the hospital.

Protruding foreign bodies

Foreign bodies embedded in the abdominal wall must not be removed except at surgery. Doing so may cause a lethal hemorrhage. Use bulky dressings, or supportive bandages to maintain the position of the protruding foreign body and to protect the patient from further injury.

Do not delay the rapid transport of patients with penetrating foreign objects to complete complicated dressings that can be done en route to the hospital.

Non-traumatic abdominal emergencies

The acute abdomen

The term "acute abdomen" refers to any severe problem involving the abdominal organs. The acute abdomen is recognized through the signs and symptoms of peritoneal irritation. Inflammation of the peritoneum — peritonitis — is primarily indicated by severe pain, especially on movement or palpation. Other signs and symptoms include nausea and vomiting, fever, and abdominal wall rigidity. Peritonitis also causes an ileus of the bowel, which means a paralysis of the normal intestinal peristaltic movement. With the presence of ileus, the bowel may become distended and produce abdominal distension, which will add to the pain and cause nausea and vomiting.

Peritonitis is commonly caused by acute appendicitis, perforation of a peptic ulcer, inflammation of the gallbladder, or in women, pelvic inflammatory disease or ectopic pregnancy. Any condition that allows pus, blood, urine, gastric juice, intestinal contents, or feces to come in contact with the lining of the abdominal cavity — peritoneum — can produce the signs of an acute abdomen.

Examination of the patient with the acute abdomen

The examination of the patient with acute abdomen should be brief and gentle:

- Observe the patient's position during the scene assessment and primary survey.
- Assess the patient's vital signs For patient's that are in the rapid transport category, assessing the patient's vital signs is conducted en route to medical aid or after the patient has been packaged while waiting for transport.
- Obtain a history of the illness or injury; use the mnemonic PPQRRST to assess pain.
- During the head-to-toe examination, examine the abdomen for bruising or signs of trauma. Check for abdominal distension and gently palpate the abdominal wall for rigidity. Identify and record the location of pain.
- Reassess and record the patient's vital signs every 10 or 30 minutes.

Management of the patient with the acute abdomen

The attendant should be aware that swollen or distended abdominal organs are very fragile and may be damaged by rough handling and excessive movement. As the degree of pain and tenderness usually indicates the severity of the problem, the attendant can assess the urgency of the abdominal situation through examination. If the attendant suspects an acute abdominal condition, the patient is in the rapid transport category. If the history or mechanism of injury permits, these patients should be placed in the position of comfort (usually semi-recumbent — see Figure 23-4) and transported to hospital immediately (see Figure 23-5).

Figure 23-4 Semi-recumbent position

Figure 23-5 Basket stretcher and blankets for transporting semi-recumbent

Genitourinary injuries

The urinary system removes waste products from the blood and eliminates them from the body. The kidneys are solid urinary organs.

The genital system is involved with reproduction. The female reproductive system (uterus, ovaries, and fallopian tubes) is situated in the lower abdomen, protected by the pelvis. The male reproductive system (testicles, vas deferens, and penis) is mostly outside the abdomen

Genitourinary system

Urinary system

The main parts of the urinary system (see Figure 24-1) are:

- Two kidneys
- Two ureters
- Urinary bladder
- Urethra

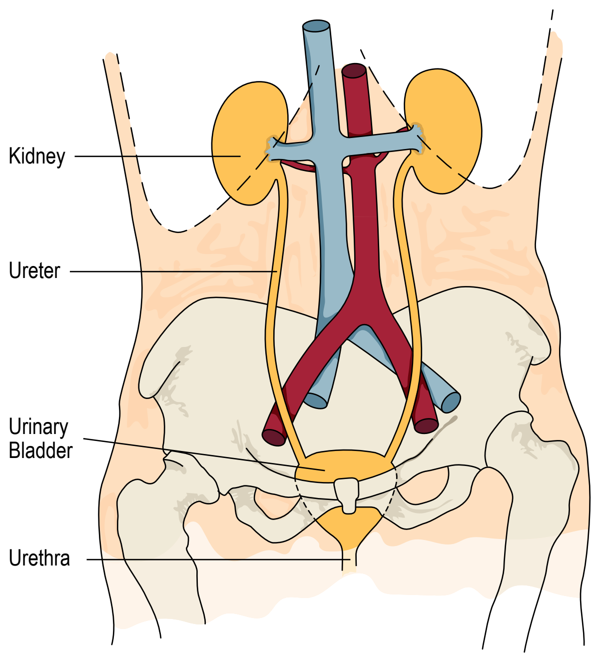

Figure 24-1 The urinary system

Kidneys

The kidneys lie against the muscles of the back in the upper abdomen, behind the peritoneum (the lining of the abdominal cavity). Posteriorly, they are protected by the ribs of the lower chest wall.

The kidneys consist of a large number of microscopic filtering units that filter the blood, removing certain body wastes and excreting them as urine. These filters have the unique ability to conserve important body chemicals and fluids, and to get rid of only the unwanted material. The urine produced by the kidneys then passes down through small tubes called ureters leading to the bladder.

Ureters

The two ureters are long, slender, muscular tubes that extend from each kidney down and into the urinary bladder. The muscle of the ureters is capable of the same rhythmic contraction found in the digestive system, known as peristalsis. The peristaltic action moves the urine along from the kidneys to the bladder at frequent intervals.

Urinary bladder

The bladder lies behind the pubic bone when empty. As it fills, it rises up into the abdominal cavity. The urinary bladder functions as a temporary reservoir for urine. When the bladder is full, sensory cells send messages to the brain that the bladder is ready to be emptied. When it is time to urinate — void — the bladder contracts, forcing urine through the urethra and out of the body.

Urethra

The urethra is the tube that extends from the bladder to the outside, through which the bladder is emptied. The urethra is longer in men than in women and is also part of the male reproductive system.

Genital system

Reproduction occurs by sexual and asexual means. In most multicellular organisms — such as humans — sexual reproduction is the prominent method. Sexual reproduction requires genetic material from the male and the female to combine. The specialized sex cell from the male is called a sperm. The specialized sex cell from a female is called an ovum. The two different cells unite to for an embryo. As the embryo matures, it becomes a fetus. The function of the reproductive system is to produce these specialized sex cells, and to allow for their union and growth.

Male reproductive system

The male reproductive system consists of the testicles, seminiferous tubules and vas deferens, seminal vesicles, prostate gland, urethra, and penis (see Figure 24-2).

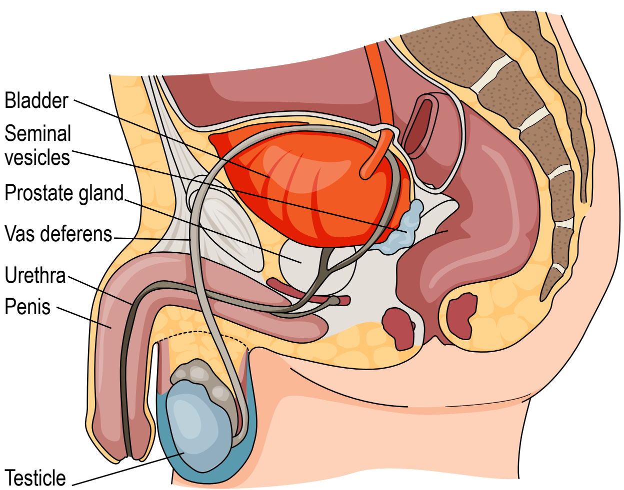

Figure 24-2 Male reproductive system

Testicles

There are two testes (testicles), which are found outside the abdominal cavity in the scrotum, located inferior to the pubic bones and anterior to the anus. The perineum is the area between the scrotum and the anus. Each testicle is oval in shape and consists of specialized cell types. The male sex hormones (testosterone) and the sex cells (spermatozoa)are produced here.

Seminiferous tubules and vas deferens

The seminiferous tubules collect the sperm from the testes. One leaves each testis, but then they combine to form a larger tube called the vas deferens. This then travels up and out of the scrotum, under the skin of the abdominal wall for a short distance. It then passes through an opening in the abdominal wall called the inguinal canal and into the abdominal cavity. From there, it extends down to the prostate gland, where it joins the urethra.

Seminal vesicles

The seminal vesicles are two storage pouches situated posterior to the urinary bladder. They receive and store the spermatozoa. The vesicles empty into the urethra at the prostate.

Prostate gland

The prostate gland, about the size of a walnut, surrounds the urethra where it exits from the urinary bladder. The prostate adds its secretions to the spermatozoa from the seminal vesicles, and the resulting fluid is called semen. The semen is expelled from the urethra by rhythmic contractions of the vas deferens and prostate. This expelling is called ejaculation.

Penis

The external male genital organ, through which the urethra passes, is composed of erectile tissue. This tissue, when distended with blood during sexual activity, allows the penis to become erect. The foreskin (prepuce) is a fold of skin that covers the tip of the penis (the glans). This fold of skin is removed in circumcised males.

Female reproductive system

The female reproductive system consists of the ovaries, fallopian tubes, uterus, vagina, and vulva (see Figure 24-3).

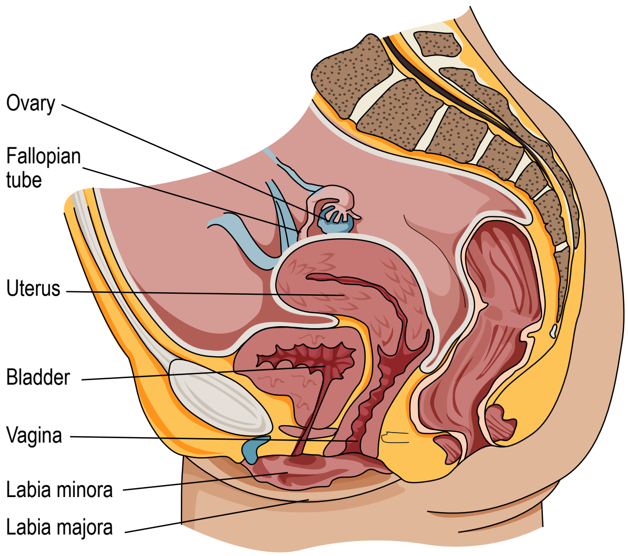

Figure 24-3 Female reproductive system

Ovaries

Two small, oval-shaped glands on each side of the pelvic cavity produce female hormones and the female sex cells (ova). A mature ovum is released by an ovary (ovulation) about every 28 days (the menstrual cycle) from puberty to menopause.

Fallopian tubes

There are two fallopian tubes, one leading from beside each ovary to the uterus, which is near the centre of the pelvic cavity. The fringe-like end of each tube near the ovary is open and the ovum is drawn into the tubes. It is carried to the uterus by peristalsis.

Uterus

The uterus is a hollow, muscular, pear-shaped organ in the centre of the pelvic cavity. The bottom, narrow part is firmly attached between the urinary bladder and the rectum. The upper, larger portion is movable and held in place by ligaments. The lower, narrower part of the uterus, which enters the upper part of the vagina, is called the cervix. There is an opening in the cervix that allows the passage of sperm from the vagina into the uterus, and of menstrual fluid from the uterine cavity into the vagina. When a baby is born, it passes from the uterus through the dilated cervix and vagina (the birth canal).

Vagina

The vagina is a muscular, distensible tube connecting the uterus with the external female genitalia (vulva). It is situated behind the urethra and in front of the rectum. During intercourse, semen is deposited into the vagina.

Vulva

The external parts of the female reproductive system or vulva consist of the labia (major and minor) and clitoris. The perineum is the area between the vaginal opening and the anus.

Genitourinary injuries

About 10% of injuries requiring hospital care involve the genitourinary (GU) system to some degree. Early recognition is desirable to prevent serious complications.

Assessment

The primary assessment is directed toward hemorrhage or shock, or any other associated life-threatening injury that may be present.

A detailed history of the mechanism of injury should be taken. Special concern for GU system injury should arise with the following types of injuries:

- Direct blows to the kidney or other GU structures
- Fractured pelvis
- Sudden deceleration injury

Inspection

The attendant should look for evidence of bruising or swelling, which may suggest deeper injury. Where practical, the urethral opening is checked for evidence of bleeding.

Palpation

The attendant should feel the abdomen. Generalized tenderness may represent a perforated organ, internal bleeding, or leakage of urine. Localized tenderness over a kidney or lower posterior ribs should raise the level of suspicion of a kidney injury.

Signs and symptoms of genitourinary injury

- Blood in the urine
- Difficult or painful voiding following trauma
- Blood at the urethral opening
- A penetrating wound, bruising, or tenderness over the kidney (flank)
- Fracture of 10th, 11th, or 12th ribs
- Tenderness or bruising in the lower abdomen or groin

Kidney injuries

Most kidney trauma is minor but warrants close observation. Major bleeding from kidney trauma is rare. Blood in the urine is common following blunt kidney trauma.

Bladder injury

The bladder is normally protected by the pelvis. Pelvic fractures can result in bladder injury — e.g., a rupture of a full bladder. When the pelvis is fractured, blood loss can also be significant.

Urethral injuries

Urethral injuries occur most often in men, usually following a straddle injury or a pelvic fracture. They are rare in women, and are not common generally. The most reliable finding is blood at the urethral opening and/or difficult or painful voiding.

Injury to external genitalia

Injuries to the external genitalia are often very painful due to the extensive nerves in the region. The patient may be very anxious. The attendant must use care and be gentle.

The evaluation and management of a patient with genitourinary injuries follows the priority action approach outlined on page 18.

External genital injuries should be dressed with sterile moistened bandages. Bleeding can usually be controlled with direct pressure. Ice may alleviate pain. The simplest dressing is a diaper-type bandage. Retain and preserve any detached tissue (see page 222, Management of Severed Parts), packing it in a saline dressing and transporting it with the patient. Transport the patient in the position of most comfort.

Injuries during pregnancy

The attendant must be aware that a seemingly minor mishap may have serious consequences for the pregnant patient. Any blunt trauma (e.g., a motor vehicle accident, fall, or blow to the abdomen) even minor, must be considered potentially serious and requires medical assessment. These injuries can result in delayed conditions that could threaten the life of the fetus or mother. Follow the priority action approach. In the absence of any abnormalities of airway, breathing, and circulation, the attendant should look for and specifically ask about:

- Abdominal pain
- Periodic pains of labour
- Vaginal bleeding
- Vaginal leakage of clear fluid that surrounds the fetus (amniotic fluid)

Pregnant patients with any of the above findings are in the rapid transport category.

Often, there may be hidden injuries that could threaten the fetus or the mother. Therefore, all pregnant patients without any of the above abnormalities, even with normal vital signs, must be referred to hospital by routine transport.

Management of injuries in the pregnant patient

1. Conduct a scene assessment.
2. Perform ABC interventions, if necessary.
3. Administer oxygen at a flow of 10 L/min.
4. Determine the need for and mode of transportation.
5. Place the patient, ideally, on her left side. This improves perfusion of the fetus. If, as a consequence of injuries, the patient must be kept supine, her right hip should be elevated. This will move the uterus to the left and improve the circulation to the fetus.
6. Conduct a secondary survey.
7. If there is a discharge or bleeding from the vagina, provide an absorbent material at the vulva such as a sanitary napkin or well-padded dressing. Do not pack the vagina.

Obstetrical emergencies

Some of the medical emergencies occasionally encountered in pregnancy are outlined below.

Vaginal bleeding

Bleeding from the vagina during pregnancy may be caused by a variety of disorders, including:

- Miscarriage — spontaneous or induced
- A fetus growing outside the uterus — an ectopic pregnancy — in either a fallopian tube, an ovary, or the abdominal cavity
- An abnormally located placenta encroaching on the birth canal — placenta previa
- The placenta separating prematurely from the wall of the uterus — abruptio placenta

The amount of bleeding may vary. Abdominal pain or cramping, fever or shock may accompany vaginal bleeding. An undiagnosed pregnancy may present with vaginal bleeding.

Vaginal bleeding in non-pregnant women is usually caused by menstruation or a gynecological problem.

Management of vaginal bleeding

Regardless of the cause, other than menstruation, a patient with vaginal bleeding must be transported to medical aid. The severity of the patient's condition will dictate the urgency.

During transport, keep the patient warm and comfortable. Reassurance may also be helpful. Do not attempt to pack the vagina. It will not control the bleeding and it may be harmful.

Toxemia

The early stage of toxemia in pregnancy is called pre-eclampsia. This abnormal condition of pregnancy may include high blood pressure, headache, agitation, or swelling of the extremities. The advanced stages of toxemia may include seizures and coma.

Management of toxemia

Any stimulus may cause a pregnant patient with toxemia to have a seizure. Therefore, handle the patient gently and avoid excessive noise and bright lights.

If seizures occur, protect the patient from injury to herself or the fetus, and keep her airway open. Ideally, position her on her left side as this will improve perfusion of the fetus. If the patient must be kept supine, elevate her right hip with a pillow, as this will move the uterus to the left and improve the circulation to the fetus.

This is a life-threatening emergency for mother and fetus; therefore, all pregnant patients suspected of having toxemia are in the rapid transport category.

Part 9

The Skin and Soft Tissues

Part 9 The Skin and Soft Tissues

The priority action approach to the walk-in patient

The majority of the attendant's work will be the management of injuries and illnesses when workers report to first aid for care. These so-called "walk-in" patients may have injuries ranging from small cuts, scrapes, and sprains to injuries or illness requiring transportation by ambulance.

When managing walk-in patients, the attendant may modify parts of the priority action approach depending on information gathered during the management of the patient. Information about what happened, the mechanism of injury, and the patient's appearance, as well as the type and severity of the wound or the history of illness, will enable the attendant to decide the course of management appropriate for each injured or ill worker.

Scene assessment

From the moment the patient enters the first aid room, the attendant begins to make decisions about the management of the patient. These decisions will include the position in which the patient should be managed, the possibility of cervical spine injury, and the need for medical aid (depending on the obvious severity of the injury or illness). The key focus of scene assessment of the walk-in patient is the mechanism of injury and/or the history of illness.

Mechanism of injury

The attendant must thoroughly explore what happened to the patient. Questions should be asked to determine what energy was exerted on the body, where this energy contacted the body, and the location of the pain. This could alert the attendant to possible underlying damage in the case of blunt trauma. What questions are asked and how detailed this questioning becomes depends on what the patient says happened. For example, it doesn't make sense to ask if the patient fell and hit their head when the patient says the wind blew some dust in their eye.

For more violent mechanisms these questions may alert the attendant to the need for C-spine control C-spine control is necessary if the mechanism of injury suggests cervical spinal trauma. How the patient is standing or moving and what part of the body is being supported can give clues about the area injured and the severity of the injury. The patient may also have to lie down because of a particular injury such as a penetrating injury to the eye.

Hazards and number of patients

The attendant should enquire about any hazardous conditions that may still exist at the incident site. The patient or witnesses should be asked if anyone else is hurt or in danger.

Modified primary survey

Patient positioning

- The attendant must decide if the patient is well enough to be managed in the sitting position or if they must be positioned supine (lying down).
- If, according to the scene assessment, and the attendant's general impression of the patient, conditions allow the patient to be managed sitting in the treatment chair, then the attendant can modify the primary survey and conduct a visual/verbal assessment of the patient. The attendant must be prepared to lay the patient down and continue with more careful assessments any time the patient's condition begins to deteriorate, if there is anything unusual about the patient's airway, breathing, appearance, or colour, the patient should be helped to a horizontal position and the attendant should conduct a hands-on primary survey.

Anxiety, light-headedness, or dizziness

- The attendant should lay the patient down if they are is anxious, light-headed, or dizzy. This may help to calm the patient and also prevent the possibility of the patient falling from the chair.
- The attendant should provide some immediate patient care for the injury if at this point critical interventions are not required. This can include supporting the injured part, covering obvious exposed open wounds with sterile dressings, cooling burns, and flushing eyes. exposed open wounds with sterile dressings, cooling burns, and flushing eyes.

Airway/Breathing Assessment

The attendant will have gathered enough information for much of the primary survey when questioning the patient about the mechanism of injury. If the patient answers these questions clearly, it can be determined that the airway is clear. From the patient's appearance and response to these questions, the attendant will also be able to determine if the patient is breathing easily and at a normal rate.

Airway/breathing distress

If there are signs of stridor or an inhalation injury or breathing distress, the attendant should position the patient according to the mechanism of injury or history of illness. Assisted ventilation may be required according to the criteria for assisted ventilation on page 60.

Circulatory assessment

The patient's colour, observed during the management to this point, may indicate to the attendant that there is a possibility of shock. If the patient is pale, they should already be lying down and the primary survey done thoroughly.

It is usually not necessary to conduct a "hands-on" rapid body survey on a patient whose condition allows them to be sitting in a treatment chair. This can be accomplished by asking the patient if they hurt anywhere else.

Bleeding

Following the 3 Ps of hemorrhage control, the attendant should lay the patient down if there is severe bleeding.

Transport decision

In many cases, the attendant can decide at this time whether the patient needs to be referred to medical aid. The patient may have obvious fractures, crush injuries, or other injuries on the list for referral to medical aid on page 214. With less obvious injuries, the attendant may not be able to determine the need for referral until the injury area is thoroughly examined during the modified head-to-toe examination of the secondary survey.

Secondary survey

The transport decision affects how much the attendant may modify the secondary survey it may be appropriate to assess the history before the vitals. The order of operations will depend on the patient's chief complaint.

- Vital signs — If the patient requires referral to medical aid, or the patient complains of any unusual symptoms (e.g., headache, nausea, "I don't feel well"), the attendant must assess and record the vital signs.
- History taking — The history taking is modified because the in-depth exploration of pain using the acronym PPQRRST, required in the case of a spinal or body trunk injury, is rarely needed.
- Head-to-toe examination — The head-to-toe examination is modified to include only the area of injury.

Vital signs

The vital signs must be assessed if the patient with a minor wound is being referred to medical aid. This will provide the attendant with an overall picture of the patient's condition and will help in deciding whether the patient can be transported to medical aid ambulatory (walking) or must be transported by stretcher. The vital signs also provide a permanent record, back at the workplace, of the patient's initial condition.

If the patient is transported to medical aid, a copy of the patient assessment chart is sent with them. A record of the patient's vital signs should also be kept at the workplace and become part of the entry in the First Aid Record.

The attendant may decide, during the modified head-to-toe examination, that a patient previously assumed to be able to return to work now must go to medical aid. At this point the attendant must assess the patient's vital signs before continuing with the treatment — unless the patient is in the rapid transport category, in which case the vital signs are assessed en route or while awaiting transport to medical aid.

History taking

The history taking for the patient with a minor wound is modified to include only questions relating to how the injury being managed is affecting the patient's overall condition. The aim is to find out:

- If the patient has allergies and whether they may have been exposed to any known allergens
- If the patient is taking medications, what the names of them are, and when the patient last took the medication
- How the patient is feeling generally, such as whether they feel nauseous or dizzy, and if the patient's tetanus immunization is up to date

Modified head-to-toe examination

The attendant must thoroughly examine the injury area to determine if medical aid is required and exactly what treatment is necessary to prepare the patient for transport or return to work.

Throughout this procedure, the attendant must continually inform the patient of what is being done and get feedback about how the injury feels as it is being examined. During palpation, it may be necessary to decrease or increase pressure, depending on the patient's reaction.

The attendant should begin the examination far enough away from the injury to discover injuries that may have occurred to proximal joints or structures. As the area closer to the injury is examined, the examination must become more thorough and specific. In the presence of any limb injury or abnormality, the attendant must compare the uninjured limb or area to the injured one.

This examination, performed slowly and carefully, begins by exposing the entire area to be examined. Then the injured and surrounding area is inspected visually. Some physical signs the attendant may look for are open wounds, discolouration, swelling, and deformity. The entire limb or area is then carefully palpated to determine possible damage to underlying structures.

The presence, location, quality, and severity of pain caused by palpation are indicators helpful in determining the type and extent of injury. For example, point tenderness is a common symptom of a fracture, given an appropriate mechanism of injury. Palpation may also reveal deformity of underlying structures.

Physical signs or symptoms of suspected injuries will further dictate what the attendant looks for. For example, the attendant would check for swollen lymph glands when the patient has an infected wound, or would feel for crepitus when tendinitis is suspected.

The wound must be examined to determine:

- Its depth
- The possibility of underlying damage
- The degree of contamination
- The presence of embedded material
- If stitches are required

This information is essential for the attendant to be able to decide upon the correct treatment for the particular injury. It also allows the attendant to decide if the patient requires medical aid or can be treated and returned to work.

The attendant next determines the circulation and nerve function distal to the injury. After the limb or area has been palpated, the attendant may know, from the colour and temperature of the skin, whether the circulation around or distal to the injury is adequate (see page 202, The Skin as an Aid to Assessment).

However, the most important assessment for circulation is to assess a pulse distal to an injury. Left and right limbs are compared. The radial pulse, in the case of upper limb injuries, and the dorsalis pedis or posterior tibialis pulse, in the case of lower limb injuries, must be assessed.

The sensory and motor nerve function is assessed by asking if the patient can feel and move areas distal to the injury. The attendant may touch the area to determine the sensory nerve function. If injuries permit and it does not cause a marked increase in pain, the patient may be asked to move the area distal to the injury to allow the attendant to assess motor nerve function.

If no serious injury is apparent by this point, it is reasonable to have the patient move the limb through a normal range of motion. If the patient can successfully perform a full active range of motion, serious injury is less likely.

It is the role of the attendant to objectively record the findings of all assessments in the First Aid Record.

First aid room procedures

As an attendant, it is your responsibility to use sterile technique when treating an injured worker. To protect yourself against exposure to blood, bodily fluids or other potentially infectious material, wear personal protective equipment and follow the workplace exposure control plan. This chapter gives guidance on the prevention of infection and on first aid equipment cleaning procedures. It also includes recommendations for record keeping and the storage and safekeeping of drugs and medicines, if these are kept in the first aid facility.

Handwashing

Prevention of infection is an integral part of wound care. In the first aid room, handwashing is the most effective method for preventing the transfer of infection from:

- The attendant to the patient
- The patient to the attendant
- One patient to another
- One part of the patient's body to another

Handwashing policies

Attendants should not wear jewellery on their fingers, with the exception of a simple wedding band. Fingernails must be clean and trimmed. Soap loosens dirt and grease, making it easy to remove them from the skin. The use of liquid soap is preferred — bar soap can contribute to transfer of infection. Running water carries the dirt and debris away. For drying hands, use disposable paper towels, discarding them in a waste container kept near the washbasin.

First aid attendants must wash their hands:

- Before and after contact with patients
- After removing gloves
- When the hands are visibly dirty
- Before eating, drinking, smoking, or going for break periods
- After using the toilet
- After blowing or wiping the nose
- After handling soiled articles, instruments, or dressings
- Before and after treating wounds
- Before going home

Handwashing procedure

1. Wet hands thoroughly under warm, running water.
2. Add soap and make lather, using a brisk scrubbing motion. Wash the fingers, palms, back of hands, wrists and under the nails. This wash should be done for no less than 10 seconds. Unlike an antiseptic, which inactivates bacteria, soap cleans by removing them and allowing them to be rinsed off. This is why it is necessary to wash vigorously when ordinary soap is used.
3. Rinse the hands thoroughly. The water should flow from the fingers back towards the wrists and arms.
4. Thoroughly dry hands with paper towels, and use a towel to turn off the faucet. Discard the used towels in the waste basket.
5. Frequent handwashing may lead to minor skin irritations. The attendant is encouraged to use a protective lotion when off duty.

Gloves

Whenever direct contact with any patient's bodily materials is possible (e.g., during care of open wounds) the use of medical exam gloves is mandatory. Gloves protect the attendant from diseases carried by bodily materials. They do not take the place of infection control (e.g., handwashing). Nitrile gloves are generally recommended. Vinyl gloves are more porous, do not provide the same level of protection, and tear easily. Latex gloves are associated with allergies.

Procedure for using gloves

1. Wash hands as previously discussed.
2. Use disposable waterproof medical gloves.
3. Wear gloves while treating the patient and while cleaning up.
4. Replace the gloves if they tear while in use.
5. Discard the gloves after treating each patient.
6. Wash hands.

Removing gloves

Gloves should be removed as soon as possible after the task requiring them has been completed. Gloves should also be removed before leaving the work area. Do not reuse disposable gloves. Use new gloves for each new task.

The following steps will help ensure that bodily materials left on the used gloves are not transferred to the attendant's skin.

1. With both hands gloved (see Figure 26-1a):

Figure 26-1a Gloved hands

   a. Grasp the outside of one glove at the top of the wrist (see Figure 26-1b).

Figure 26-1b Grasp the glove

   b. Peel off this glove from the wrist to fingertips, turning it inside out while pulling it off your hand and away from you (see Figure 26-1b and 26-1c).
   c. Hold the removed glove in the gloved hand.

Figure 26-1c Peeling off gloves

Figure 26-1d Grasp the glove, pulling away from you

Figure 26-1e Turn glove inside out

2. With the ungloved hand:
   a. Peel off the second glove by grasping it on the inside at the top of the wrist.
   b. Turn the glove inside out while pulling it away from you, leaving the first glove inside the second glove (see Figure 26-1d and 26-1e).
3. Dispose of the entire bundle promptly in a waterproof garbage bag.
4. Wash your hands thoroughly with soap and water as soon as possible after removing gloves and before touching non-contaminated objects or surfaces.

Eye protection

The attendant should use appropriate eye/face protection in the form of safety glasses or a face shield if there is a possibility of the eyes, nose, or mouth being splashed by bodily materials. The treatment of a subungual hematoma is an instance where there is a danger of blood hitting the attendant.

Cleaning equipment and furniture

The attendant is responsible for maintaining the cleanliness of equipment and furniture in the first aid room and ambulance. This involves two processes: washing and disinfecting.

Because soil protects microorganisms from contact with the disinfecting agent, the equipment and furniture must be washed with a detergent and water prior to being disinfected. Any organic matter must be removed.

Some disinfecting solutions cause metal instruments to rust and may damage plastic. Chlorine-based preparations are examples of such solutions. Where the use of chlorine bleach (household bleach) is recommended, a buffered chlorine solution that is less corrosive, such as sodium dichloroisocyanurate (e.g., Presept™ tablets dissolved in water) is preferred.

Because the chemicals mentioned in this section are considered hazardous materials under the Workplace Hazardous Materials Information System (WHMIS), a safety data sheet (SDS) must be available for each chemical. Proper storage and ventilation must be ensured, and all WHMIS requirements must be followed.

Procedures

Metal instruments

1. Wear eye protection and impervious gloves. Nitrile rubber, which is resistant to bleach and isopropyl alcohol, is recommended.
2. Wash instruments thoroughly with detergent and water, removing all debris. Take care when washing thermometers that the water is not too hot. The use of disposable thermometers may be considered.
3. Rinse the instruments well with tap water and shake off the excess.
4. Place the instruments in a clean container with 70% isopropyl alcohol — enough to completely cover the instruments — for 15 to 20 minutes.
5. Remove the instruments from the soaking container using lifting forceps. Allow the instruments to air dry and store them in a covered storage container that has been disinfected. Do not store in solution. Storage containers must be disinfected weekly.

Isopropyl alcohol evaporates and thus becomes less concentrated, which decreases its effectiveness. The soaking container must have a lid, and the solution must be changed at least weekly. It is suggested that the changes be recorded in a written log. Isopropyl alcohol is also flammable, so it should be stored in a cool, well-ventilated area where smoking is not permitted.

Sterilization, which kills all microorganisms, is rarely required in a first aid setting. If sterilization is necessary, a tabletop autoclave may be used, following the manufacturer's instructions. Instruments may also be immersed in boiling water for 10 to 15 minutes, after being washed with detergent and water. The sterilizing water must be changed on a daily basis to prevent contamination. Instruments must not be stored in the water.

Pocket masks

1. Wear impervious gloves. Nitrile rubber is recommended.
2. Wash masks thoroughly with detergent and water, removing all debris. The one-way valve and filter must be replaced after each patient use.
3. Rinse well with tap water and shake off the excess water.
4. Submerge in a solution of 1 part household bleach to 10 parts water — 0.5% sodium hypochlorite — for 10 minutes. This solution must be mixed fresh for each use.
5. Rinse again and allow to dry.
6. Store in a clean container.

Large equipment, first aid room, and ambulance

A routine thorough cleaning program, at least weekly, should be in place as part of the company's written policies and procedures. Stretchers, treatment chairs, tables, countertops, walls, and floors, as well as the ambulance interior, must be cleaned by the attendant following any contamination.

Blood and bodily fluid spills should be cleaned up immediately using paper towels, detergent, and water, followed by a freshly mixed solution of household bleach diluted 1:10 with water. Leave the bleach solution on surfaces for 10 minutes before wiping off.

1. Wear impervious gloves and other appropriate protective equipment such as gowns, shoe coverings, and face shields as necessary.
2. Clean the surfaces with a towel, then a detergent solution.
3. Pour the bleach solution on the surfaces, leave on for 10 minutes, and wipe off.
4. Use a cleaning bottle on all hard-to-reach areas — e.g., the stretcher frame. An aerosol bottle must not be used for this as the vaporized droplets are harmful when inhaled.

Prescription and non-prescription drugs and medications in the workplace

Prescription drugs and medications

Prescription drugs and medications can be obtained only with a prescription from a physician. Such prescriptions will be specific to a worker.

For the first aid treatment of a specific worker (e.g., for angina or diabetes) a letter from the prescribing physician must identify the following for the prescribed drug or medication:

- The name of the worker to whom it is prescribed
- Its specific use expiry date and storage
- Possible and expected reactions to the medication
- Possible complications and/or side effects
- The dose and method of application

Non-prescription drugs and medications

Non-prescription products are those that may be purchased over the counter by any person.

An employer may choose to purchase non-prescription drugs or medications to address common ailments. The attendant should have control over supplying the drugs and/or medications to the workforce. Several steps must be followed prior to supplying drugs or medications to a worker:

- The attendant must be familiar with the indications for use, contraindications, and side effects listed by the manufacturer of each drug or medication kept in stock. Of particular concern are drugs or medications that cause drowsiness or interfere with manual dexterity required by workers to perform their duties safely.
- The attendant must check and strictly adhere to the expiry date of the drugs or medications.
- The attendant must obtain a history of events that led up to the worker asking for relief.
- The attendant must determine if the worker is currently taking any medication, and if so, the appropriateness of taking additional medication, with possible interactions.
- The attendant must inform the worker of the side effects and contraindication (reasons why they should not take it) of the medication to be taken.
- The attendant should make an entry in the first aid record.
- The attendant must be familiar with the route of administration. Not all medications are taken orally.

Records and reports

The attendant's duties include keeping records of all workers presenting to first aid. It is very important that these records and reports be clear, concise, and correct. Although prompt and effective first aid treatment is always the attendant's first priority, an accurate and factual account of each patient's condition, from the time of the incident until arrival at a medical facility, is also of great importance. All the necessary information may not be available to the attendant at the time of the accident. It must be gathered and recorded as soon as possible afterward. With experience, the attendant will learn to obtain most of the information required while giving care to the patient.

First aid record

The first aid record is completed whenever an attendant sees a patient. This may be for the initial report of the injury or illness, or for a subsequent visit due to a re-injury, or for redressing or reassessment. All information in the first aid recordmust be kept confidential. This record is an important tool for the attendant as well as serving an essential function for the employer and injured worker.

For the attendant, the first aid record provides:

- A history of the injury when the attendant must redress or re-evaluate an injury
- Information for injury and patient follow-up about injuries that have occurred on previous shifts or when other attendants were on duty
- A picture of a worker's improvement or deterioration for a progressive condition such as tendinitis signs of infection or when the attendant is monitoring a worker on a return-to-work program

- For the employer, the First Aid Record:
- Provides information essential to the company's health and safety program
- Identifies trends in the type and severity of injuries or illnesses in the workplace so action can be taken
- Identifies work areas and practices that may be causing injuries or illnesses so action can be taken
- Provides information for comparison to claims statistics when assessing the effectiveness of the company's first aid and health and safety programs
- Provides a written record of the occurrence and evidence of injuries or illnesses in case a compensation claim results in the future
- For the worker, the First Aid Record:
- Ensures proper follow-up or subsequent treatments because any attendant will be fully aware of previous assessments, conditions, and treatments
- Provides a written record of the occurrence and evidence of injuries or illnesses in case a compensation claim results in the future

The first aid recordmust be complete, thorough, and factual and must contain the following:

- The full name and occupation of the injured worker
- The date and time of the injury or report of illness
- The date and time the injury or illness was reported to the employer or employer's representative
- The names of witnesses
- A description of how the injury or illness occurred
- A detailed description of the nature of the injury or illness, including everything the attendant sees, feels, and is told by the worker
- A detailed description of the treatment, advice given to the patient, and any referral arrangements made for the injured worker
- The signature of the attendant or person giving first aid and, where possible, the signature of the worker receiving treatment

If no visible marks are present, this should also be recorded. All subsequent or follow-up treatments must be recorded in the first aid record.

Anatomy and function of the skin and soft tissues

Skin is an extensive and complex organ (see Figure 27-1 Skin), consisting of tough, elastic tissue that protects and covers the entire body. The skin serves two main functions:

- It protects the body from:
  - Loss of bodily fluids.
  - Bacterial invasion.
  - Alterations in temperature.
- Through its sensory receptors, it conveys information about the environment to the brain.

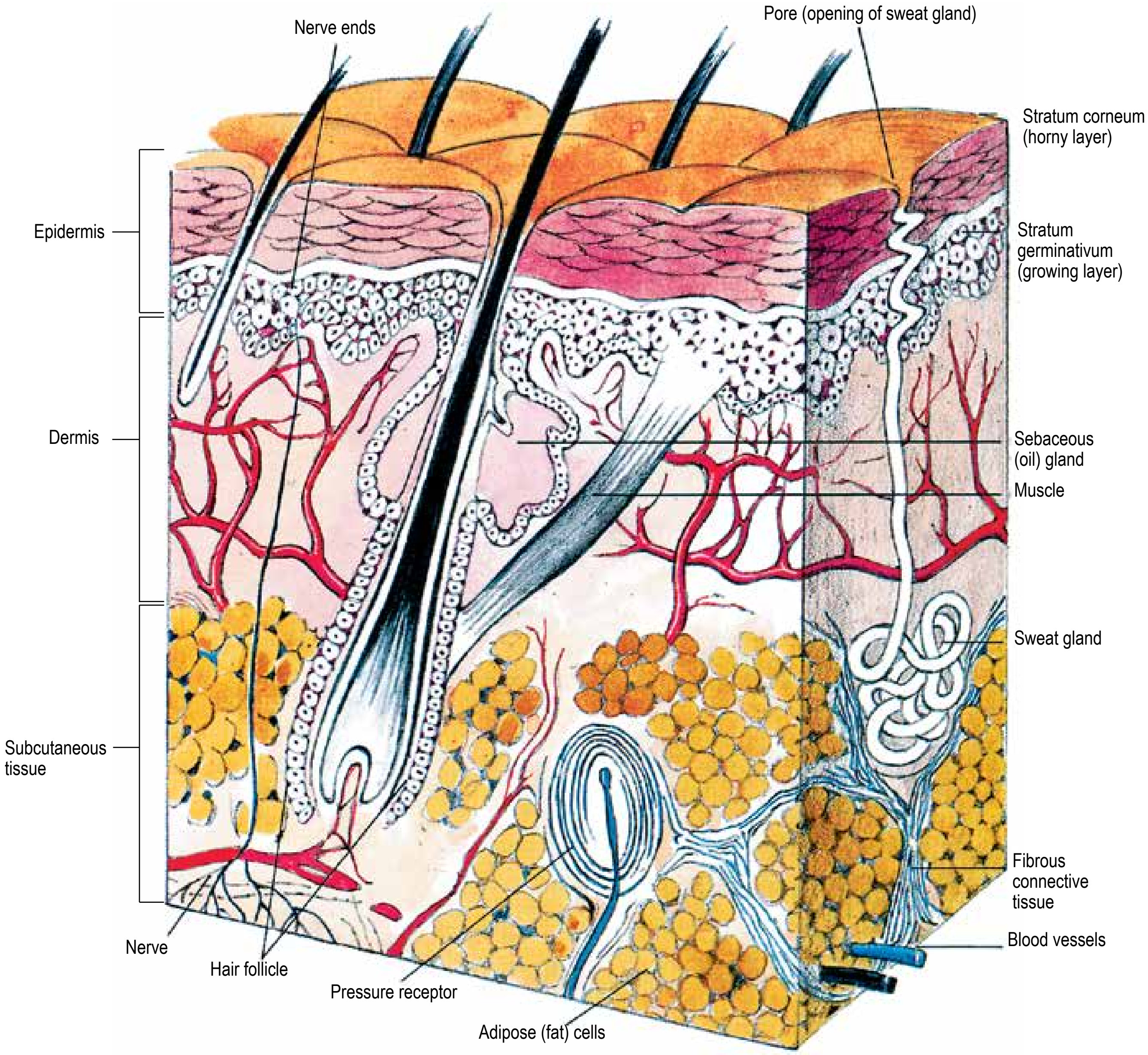

Figure 27-1 Skin

Skin anatomy

Layers of the skin

There are two main skin layers: the epidermis and the dermis. Each layer differs in structure and function.

The epidermis is the outermost covering. It is made up partly of dead, hardened cells that are constantly being rubbed off and replaced. Deeper in the epidermis are cells that constantly reproduce to replace the outer cells. Some cells in the deeper layer also contain pigment granules. These cells, together with the blood in the small vessels of the skin, give the skin its colour.

The dermis is the layer below the epidermis. It has a framework of elastic connective tissue and is well supplied with blood vessels and nerves. Many special structures are found in the dermis, including sweat glands and ducts, oil — sebaceous —glands and ducts, hair follicles, blood vessels, and specialized nerve endings.

Sweat glands discharge their contents through sweat ducts onto the surface of the skin. Sebaceous glands produce an oily substance called sebum. Sebum is important in keeping the skin waterproof and supple.

Hair follicles are the small organs from which hairs grow.

The skin as an aid to assessment

Evaluation of the skin should be part of every assessment. The skin, like any other organ, reacts to injury or illness. Because it is on the body's surface, it is accessible and very visible. It provides important information, which is easily obtained (see Table 27-1). Assessment of the skin should include checking the following:

- Colour
- Temperature
- Moisture

Possible causes of skin findings

Colour	Possible Causes
Increased redness	Fever Allergic reaction Exercise Warm environment
Pallor	Significant blood loss (hypovolemic shock) Severe pain Anemia — e.g., iron deficiency Fainting (syncope) Fear, anger Cool environment
Bluish (cyanosis)	Cold Low oxygen in blood (hypoxia) Shock
Temperature and moisture	**Possible causes**
Hot and dry	Heat stroke
Hot and moist	Hot environment Fever Exercise
Cold and dry	Cold environment
Cold and clammy	Blood loss Heart failure Shock

Table 27-1

Colour

Skin is more or less transparent. How transparent it is depends upon the number of pigment (melanin) containing cells. This number varies considerably among different races.

In fair-skinned people, the colour of the skin is an excellent indicator of the underlying circulation. In dark-skinned individuals, the mucous membranes (e.g., inside of mouth and eyelids) are a more accurate guide.

If for any reason blood flow to the skin should be reduced, the skin will become pale or mottled. This might occur with a condition that causes constriction of cutaneous — the skin — blood vessels (e.g., shock, heart failure, cold). Pale skin may also occur in non-life-threatening situations as a normal reflex response (e.g., to severe pain or vomiting).

If the cutaneous blood vessels should dilate, resulting in increased blood flow to the skin, the skin will become pink or red.

Temperature

Skin temperature increases directly with increasing cutaneous blood flow. Conversely, skin temperature falls with vasoconstriction. This is part of normal temperature regulation. For example, in a hot environment, more warm blood is diverted to the skin, to allow it to lose some body heat to the surrounding air. In shock, blood is diverted from the skin to the body core to minimize blood loss and to provide the vital organs with the available blood. This results in cool skin.

Sweating also helps to regulate temperature by water evaporation.

Moisture

Stimulation of the autonomic nervous system — due to the release of adrenalin and noradrenalin — also results in sweating (e.g., in shock and exertion).

Subcutaneous Tissue

The subcutaneous layer is a combination of connective tissue and fat. This layer connects the skin to the surface muscles. The fat in this layer of tissue serves as the body's main insulation. Fat also functions as a reserve of energy.

Muscle

Muscle is a special kind of tissue capable of forceful contraction. Figure 27-3 depicts some of the muscles of the body.

There are different types of muscle tissue (see Figure 27-2 Types of muscle tissue); each is uniquely designed to carry out specialized functions:

- Skeletal muscle — responsible for body movement
- Smooth muscle — responsible for constriction of the blood vessels and peristaltic activity in the gastrointestinal and genitourinary systems
- Cardiac muscle — responsible for the automatic pumping of the heart

All muscles have arteries, veins, and nerves. They cannot function without a continuous supply of nutrients and oxygen, and the removal of waste products. Muscles are under the direct control of the nervous system.

Skeletal Muscle

Skeletal muscles are attached to the skeleton. They are also known as voluntary muscles because they can contract on demand.

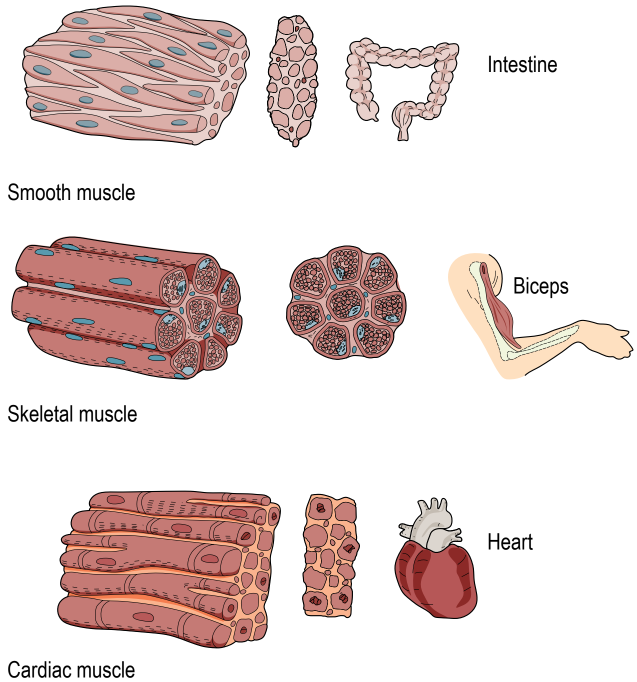

Figure 27-2 Types of muscle tissue

Muscle movement

All types of muscle attachments are designed to harness the power of muscle contraction. Both ends of a muscle are usually attached — via tendons — to bone. A muscle acts on an appropriate impulse from its nerve supply. These nerves are called motor nerves. In muscular contraction, the muscle is shortened. This pulls on the attachments at each end and brings them nearer to each other, causing movement (see Figure 27-4 Muscle movement).

Skeletal muscles pass over or across joints, permitting body movement. Most skeletal muscles exist in groups or pairs, which have equal but opposite functions. Voluntary contraction of one group of muscles is accompanied by automatic relaxation of the opposing group. This relaxation retains just enough tension to make the movement smooth and keep it under control. Muscles can only contract and relax, they cannot push.

Muscle tone

Muscle tone is controlled by the nervous system and keeps the muscles in a constant state of readiness.

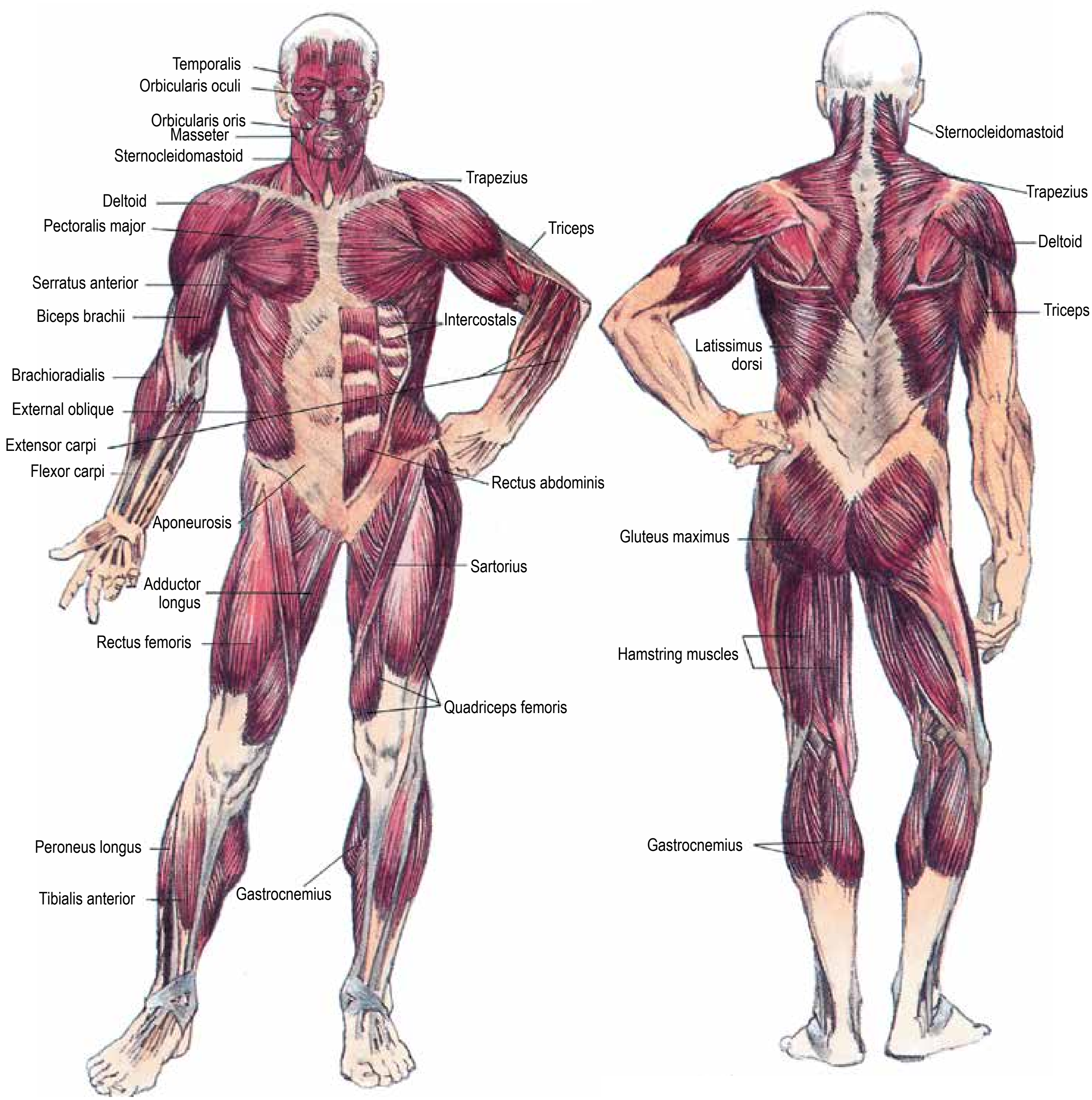

Figure 27-3 Muscles of the body

Smooth muscles

Smooth muscles are involuntary and under the control of the autonomic nervous system. These muscles contract without a person's conscious thought.

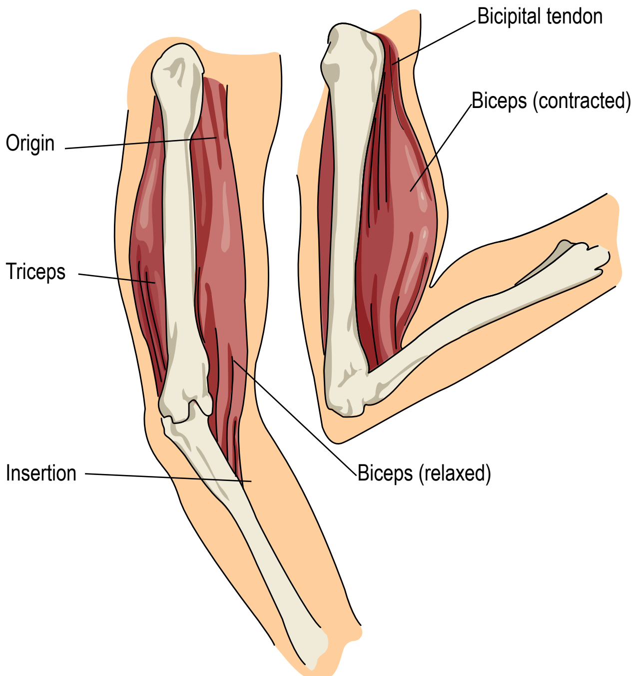

Figure 27-4 Muscle movement

Smooth muscles are found in the:

- Digestive tract, where they move nutrients and waste materials along (peristaltic activity)
- Blood vessel walls, where they regulate blood flow
- Tubes (ureters) that carry urine from the kidneys
- Walls of the bronchial tree, which regulate air flow

Cardiac muscle

The cardiac muscle is highly specialized, possessing an intrinsic rhythm that allows it to contract and relax automatically. The rate and strength of contractions are controlled by the autonomic nervous system.

Tendons

A tendon is a band of strong, white, fibrous tissue that connects a muscle to a bone. When the muscle contracts or shortens, it pulls on the tendon, which moves the bone. Tendons are so tough they are seldom torn.

Ligaments

Ligaments are fibrous tissue bands that connect one bone to another at a joint. They are found in all free-moving joints (e.g., the knee) and also the less mobile joints (e.g., the sacroiliac joint).

Inflammation and healing

Inflammation is a localized protective response of the body to an injury, or exposure to an irritant or infectious agent. In an attempt to isolate the offending agent, local blood vessels dilate, bringing in special cells to initiate healing and prevent further injury.

Inflammation

The agents that may cause inflammation include:

- Infection — e.g., bacteria
- Physical injury — e.g., contusion, crush, abrasion, laceration, penetrating foreign body, strain, or overuse
- Chemical injury — e.g., acid or alkali burn (see Figure 28-1 Inflammation), which depicts the inflammation response

The stages of the inflammatory process are the same, regardless of cause, and can be summarized as follows:

1. The injured tissue cells release certain substances into the blood, which trigger the response.
2. The local capillaries dilate, greatly increasing the blood supply to the body part. This can be easily observed as a reddening of the skin overlying the injury.
3. The local capillaries become relatively porous, allowing plasma to leak into the region of the injured tissue. This results in swelling and usually pain. The pain arises from both direct damage to the local nerves, and stretching of the nerves due to swelling. That is why, in tissues where there is little room for swelling (e.g., in the fingertip, nose, ear canal) the pain can be so acute.
4. Cellular elements (e.g., white blood cells) also accumulate. Some of the cells attack and kill infectious organisms, others carry away dead cellular debris, and still others attempt to neutralize toxins.

The excess plasma, together with some of the cellular elements, make up inflammatory exudate. It can often be seen to ooze from raw or open tissue (e.g., after a burn or abrasion) as a clear, straw-coloured fluid.

The local signs of inflammation are:

- Heat
- Swelling
- Redness
- Pain

Some infectious agents produce enough toxins to make the patient feel generally ill and may also result in fever.

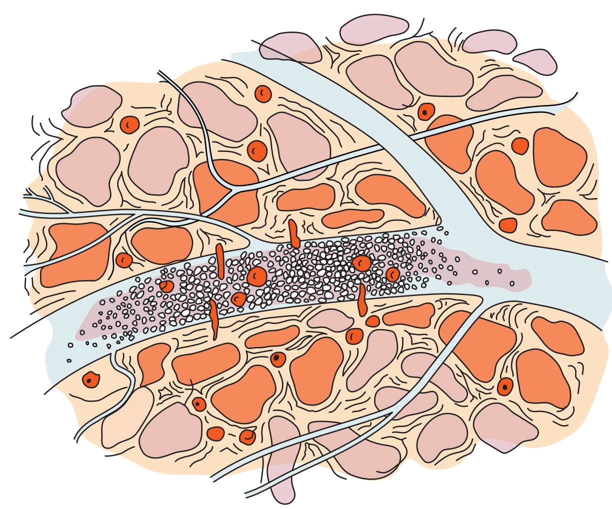

Figure 28-1 Inflammation

Clinical varieties of inflammation

Inflammation may run its course without destroying any tissue or it may cause local tissue death.

Some bacteria produce tissue toxins powerful enough to actually kill the tissue — gangrene — in which they are concentrated. This is especially true in tissues where there is no room for swelling, and the resulting collapse of the local capillaries hastens tissue death due to lack of oxygen.

Pus

Pus is an inflammatory exudate containing white blood cells, often dead, as well as cellular debris from dead tissue. Pus also contains germs, some of which are still alive, and therefore infectious.

Abscess

An abscess (boil) is a localized collection of pus within the tissues, usually found in hair-bearing areas of the skin — e.g., back of neck, axilla. For treatment, see page 219, Abscess.

Cellulitis

Cellulitis is a diffuse, spreading inflammation, found between the skin and underlying tissues. It is caused by an infectious organism. It occasionally may spread from an abscess, but more often arises locally after a penetrating skin wound, even a minor one. Cellulitis may also occur in an area without a skin wound if bacteria travel through the blood from another site — e.g., leg cellulitis from an ingrown toenail.

The surrounding area is hot, red, and swollen, and fades gradually at the edges. Mild local infections may be treated with hot compresses. More serious degrees of infection, as with abscesses, must be referred to a physician.

The lymphatic system

The body's circulatory system is made up of the arterial system and the venous system. A third network of vessels makes up part of the lymphatic system. Lymph vessels are less visible than the arteries and veins, but are present throughout the body and serve a very necessary function.

Lymph is the bodily fluid that accumulates in the tissue spaces between cells. Lymph and the bodily fluid that collects at the site of an infection is collected by the lymph vessels and carried away to the local lymph nodes — glands. The lymph glands effectively remove any infectious organisms before allowing the lymphatic fluid to return to the bloodstream.

If bacteria escape into the general circulation, a condition known as septicemia can develop. Without antibiotics and medical care, this is usually fatal. The lymphatic system helps protect the body from septicemia.

In addition to the lymph vessels and glands, the lymphatic system includes the spleen, an organ that produces certain blood cells.

Lymphadenitis

In the lymph nodes, bacteria are engulfed by white blood cells and other specialized cells. This process often results in the regional lymph nodes becoming swollen and tender — swollen glands — a condition called lymphadenitis. Occasionally, lymph nodes themselves may become abscessed by a particularly severe infection, but after most infections the lymph nodes return to normal.

Lymphangitis

Lymphangitis is an inflammation of the lymphatic vessel leading to the lymph nodes from the original site of infection. It may be seen as a red streak along the path of the underlying lymphatic vessel, which may be tender and swollen.

Treatment

Both lymphadenitis and lymphangitis should be referred for medical attention. In isolated areas, the treatment for a localized infection would be intermittent application of hot compresses to the affected area until medical attention is available.

Spleen

Like the lymphatic vessels and the lymph nodes, the spleen is part of the lymphatic system.

The spleen is a solid organ, about the size of a small fist, located in the left upper quadrant of the abdominal cavity. It contains soft pulp, called lymphoid tissue, which filters out old red blood cells and manufactures certain types of blood cells.

The spleen has an unusually large blood supply and may bleed profusely if injured. It is particularly vulnerable to rupture from blunt trauma to the left side of the abdomen or left lower chest.

Any patient who has suffered blunt trauma to the left abdomen or lower chest, and who shows signs of developing shock, should be suspected of having a ruptured spleen and is in the rapid transport category. Follow the General Principles of Management of Abdominal Injuries, as outlined on page 182.

Healing

Healing is the restoration of integrity to injured tissue and follows any condition that can result in tissue injury.

Basically, healing occurs by formation of scar tissue. It takes place after the local inflammatory response. The process of healing can be explained best by giving an example — the repair of a simple laceration:

1. The edges of the wound are loosely brought into contact with one another.
2. A thin layer of blood or plasma forms between the edges and produces a clot. This is essential.
3. New fibrous tissue cells begin to grow through the clot to bridge the gap, forming a loose network of new tissue.
4. Blood vessels then grow across the wound in a similar manner.
5. The cells of the deep layer of skin — dermis — are now able to grow across the wound and be nourished from below. Healing is then complete. This process usually takes five to six days, but the tissue may not be structurally sound for another week, depending upon the location of the laceration. Fast healing occurs in areas of relatively good blood supply — e.g., face — and slow healing tends to occur over bony prominences — e.g., knee, elbow, knuckle.
6. The scar reaches maximum strength in about 17 days but will continue to contract and mold for approximately a year.

If the wound edges are not brought together, a larger blood clot is required to fill the gap and healing takes longer. It also results in a bigger scar.

Where the gap in the skin is large, and cannot be closed initially, a process called “granulation” occurs. Here, meaty-looking, rough-textured tissue grows up from the bottom of the wound to the level of the surface. Then the skin grows slowly in from the sides at a rate of approximately 1 mm per day. When the skin gap is very large, skin grafting is necessary for timely healing.

Because of the loss of integrity of the body’s normal barrier to infection, any skin wound is subject to infection until healing is complete. Infection is a common complication of skin wounds (see page 219, Wound Infection).

Soft tissue injuries

Soft tissues include all body structures except organs and bones. Most injuries involve soft tissue such as skin and muscle. Any break in the continuity of tissue is classified as a wound. Breaks in bones are also classified as wounds but are referred to as fractures and are dealt with in a separate section (see page 242, Sprains, Dislocations, and Fractures). The treatment of strains and sprains is discussed in the same section.

In general, soft-tissue injuries may be categorized as follows:

- Wounds — open and closed
- Muscle or tendon strains
- Ligament sprains
- Any combination of the above

This section deals only with open and closed wounds and their management.

Wounds are of two types:

- Closed wounds — There is injury to underlying structures but no break in the skin.
- Open wounds — There is a break in the skin surface and underlying tissue may be exposed.

Closed wounds

Closed wounds may result from the impact of blunt objects or from excessive pressure or force. There may be considerable crushing of tissues beneath the skin, accompanied by internal hemorrhage.

Closed wounds range from a small bruise (contusion) to ruptured internal structures. By the very nature of closed wounds — where the damage lies beneath intact skin — the extent of injury may be difficult to assess.

The force of the injury often ruptures small blood vessels. If the injury is close to the surface, the immediate leakage of blood and plasma causes swelling and pain. A bruise or discolouration of the skin — ecchymosis — may occur within hours or days (see Figure 29-1 Bruise). A bruise looks like a black and blue mark. As the wound heals, the bruised area becomes paler, greenish-brown, and finally yellowish.

Figure 29-1 Bruise

When large amounts of tissue are injured or when larger blood vessels are ruptured at the injury site, a rapidly forming hematoma will develop. A hematoma is a collection of blood and plasma in the damaged area — swelling. A hematoma may give rise to complications that usually occur as a consequence of compression of blood vessels or nerves. This may cause circulation deficiencies, loss of use or feeling, or increasing pain in the affected extremity.

Management of closed wounds

Small contusions usually require no emergency treatment. During the first 48 hours, the application of cold and modest pressure will limit localized swelling, thereby decreasing pain and disability.

Large contusions and/or hematomas may require elevation of the injured part and appropriate immobilization, as well as the application of cold (see page 213, Application of Cold).

Closed wounds that must be referred to medical aid include:

- Significant closed wounds around joints
- Closed wounds that impair distal circulation
- Closed wounds with nerve impairment

Open wounds

With open wounds, the continuity of the skin's surface is broken, underlying tissue is exposed, and bleeding is present. Open wounds are susceptible to infection.

There are several types of open wounds:

- Abrasion
- Laceration
- Puncture
- Avulsion
- Amputation

In addition, open wounds include crush injuries (see page 222, Crush Syndrome), burns (see page 277 Burns), and electrical injuries (see page 284, Electrical Injuries). Because of their importance and complexity, these wounds are discussed in separate sections.

Abrasion

This is the most superficial type of open wound, merely roughening the skin's surface. It may be a single, fine line (a scratch) or a wide grazed area (see Figure 29-2 Abrasion). Bleeding is usually very slight, but because dirt or other foreign material may be ground into the abraded area, the wound may become infected.

Figure 29-2 Abrasion

Laceration

A laceration is a cut that may have sharp or jagged edges (see Figure 29-3 Laceration). The subcutaneous tissue, underlying muscles, and associated nerves and blood vessels may be involved. The appearance and significance of the wound relate directly to the cause (e.g., utility knife, chain saw). The extent of damage to underlying tissues may be difficult to assess. Blood loss, infection, and functional impairment are the primary complications of lacerations.

Figure 29-3 Laceration

Puncture

Puncture wounds (see Figure 29-4 Puncture) vary in size and depth, depending on their cause.

Depending on its location, a puncture may pierce major blood vessels and organs, causing rapidly fatal bleeding. Muscles, bones, tendons, and nerves may also be damaged. The attendant should be especially wary of puncture wounds to the neck, chest, abdomen, or groin because of the major organs in these areas. External bleeding is usually not severe if the wound is small. Small puncture wounds may become infected quite readily, as foreign material is driven into deep tissue, and they are difficult to clean.

Figure 29-4 Puncture

Avulsion

An avulsed wound occurs when the full thickness of skin is lost or pulled away, exposing deeper tissues (see Figure 29-5 Avulsion with compound fracture). Complications of an avulsion injury may include loss of blood, infection, and delayed healing.

Figure 29-5 Avulsion with compound fracture

Amputation

An amputation means a complete loss of a body part. When the part is almost severed, it is called a partial amputation. Bone and other tissues are often exposed. Complications may include bleeding, shock, infection, and disability.

First aid equipment for open and closed wounds

This section describes the basic items the attendant will be working with most of the time. Examples of first aid kits used in industry are depicted in Figures 29-6, 29-7, and 29-8.

Dressings

Dressings are for use in the initial covering of open wounds to prevent further contamination. They differ from bandages in appearance and function.

First aid kits and rooms are usually equipped with a wide variety of dressings (see Figures 29-9 and 29-10).

Dressings range from the common adhesive strips to very large bulky items, commonly known as abdominal dressings, ABD pads, or drainage dressings. Most commercially obtained dressings are individually wrapped for sterility. Very large abdominal or multitrauma-type dressings may be wrapped in plastic but may not be sterile. Usually these types of dressings are used as soakers. A soaker is a pad that covers the sterile gauze dressing on a wound and soaks up excess blood.

A wound dressing must:

- Be larger than the wound
- Be sterile, if possible
- Be thick, soft, and compressible, to permit evenly distributed pressure over the entire area of the wound
- Have a lint-free surface

Bandages

Bandages are used to secure dressings covering wounds. The most common types of bandages are:

- Wide elastic fracture straps; these may be connected together to lengthen them if necessary (see Figure 29-11 Wide elastic straps with Velcro attachments)
- Crepe or tension elastic rollers, usually 5 to 15 cm (2 to 6 in.) wide and 4.5 m (5 yd.) long when stretched
- Self-adhering, form-fitting roller
- Elastic adhesive-backed roller
- Gauze roller
- Tubular bandage (see Figure 29-12)
- Triangular bandage

The triangular bandage (see Figure 29-13 Triangular bandage used as a sling) is the oldest type of bandage and one of the most versatile. Fracture straps and/or triangular bandages can be used quickly and efficiently on any part of the body without moving the patient to:

- Hold dressings in place
- Apply and maintain pressure on bleeding wounds (e.g., loop tie bandage)
- Secure splints to the body or limbs

Fracture straps are wide elastic straps with hooked Velcro on one end of the strap and looped Velcro on the other end. These can be used to apply pressure on a dressing as a bandage. They can also be connected together to lengthen the strap if needed. Two or more straps connected together may be needed. A folded blanket can be placed between the legs and several straps can be used to hold the legs together. A folded blanket or pillow may be wrapped around a fractured limb and secured with the straps to achieve limited immobilization before moving the patient.

The triangular bandage is a piece of material, cotton is best, 150 to 160 cm (60 to 65 in.) in length at the base and has:

- A base
- A point
- Two sides
- Two ends

A wide bandage is made by bringing the point down to the base and then folding it once. A narrow bandage is made by folding the broad bandage a second time. When not in use, the triangular bandage should be folded as follows:

1. Fold the bandage into a narrow bandage
2. Bring the ends together to meet in the centre
3. Double the bandage upon itself

When stored like this, the triangular bandage can be unfolded to make a narrow bandage for immediate use.

Several methods can be used to secure the ends of a triangular bandage. The most common method is the square or reef knot. Square knots are recommended because they do not slip once tightened, and they can be easily untied. A surgeon's knot is sometimes used since it will not slip while being tied.

Bulky supports for large embedded foreign bodies can be made from triangular bandages or drainage dressings. If there is hemorrhage and a protruding foreign body or bone fragment, a ring pad and packing or multiple bulky dressings is recommended to provide pressure and prevent further tissue injury.

Figure 29-6 Oxygen and airway kit

Figure 29-7 First aid kit

Figure 29-8 First aid kit

Figure 29-9 First aid room

Figure 29-10 Dressings

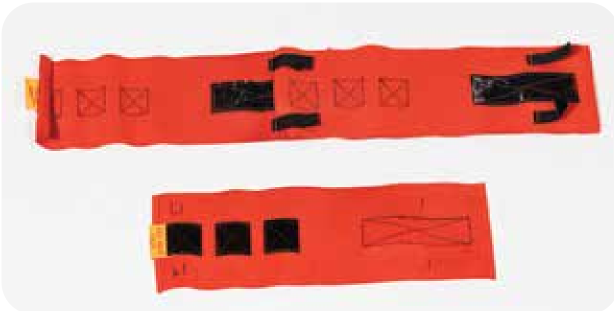

Figure 29-11 Wide elastic straps with Velcro® attachments

Figure 29-12 Tubular gauze

Figure 29-13 Triangular bandage used as a sling

Principles of bandaging

- The bandage must be tight enough to control hemorrhage and immobilize the wound but not tight enough to constrict circulation distal to the injury.
- The bandage must be applied so that pressure is evenly distributed over the entire area of the wound.
- The bandage must cover the entire dressing.
- Where possible, fingers and toes should be accessible for checking circulation and neurological function.
- Bandage knots must be accessible.
- Bandage knots must not put pressure on the body, which may cause sores.
- Roller bandages must not encircle a limb underneath splints as the bandages cannot be easily released if the circulation becomes impaired.

Management of minor wounds

The attendant must follow the procedure outlined on page 193, Priority Action Approach to the Walk-In Patient:

1. Conduct a scene assessment
2. Complete the primary survey, with appropriate modifications
3. Complete the required components of the secondary survey

An attendant must know how to assess and examine the injury and know the guidelines to identify when to refer the patient to a physician (see page 214, Referral to Medical Aid).

Many minor injuries treated by the attendant may not require medical attention. When treating minor injuries, the attendant is accepting a serious responsibility.

Application of Cold

The application of cold may be beneficial in first aid. It can help to slow bleeding and limit swelling by constricting the blood vessels and slowing the flow of blood to the area. Limiting swelling can significantly reduce the healing time in the case of fractures or sprains. Cold can also reduce pain, which in turn can lessen the patient's anxiety and help prevent shock.

The attendant must, however, use caution when applying cold. If cold is applied for more than 20 minutes at a time, it may have the opposite effect — the blood vessels may dilate instead of remaining constricted. It should be used with caution in young children, who are at greater risk for hypothermia from cold therapy. As well, because cold reduces blood flow, the attendant must be sure that there is good circulation distal to the injury before cold is applied.

Use the following guidelines when applying cold:

- Do not apply cold if the distal circulation is impaired.
- Do not apply ice in plastic bags or uninsulated cold packs directly to the skin. Place one layer of triangular bandage or a couple of layers of gauze

over the area before applying the cold. Too thick a layer of insulation will stop the cold from benefiting the patient.
- Apply cold for up to 20 minutes, remove it for 5 minutes, then reapply it. For some injuries, the patient may be advised to continue this application at home.

Referral to medical aid

The attendant should refer patients with the following minor wounds for medical treatment, as they are slow to heal and prone to infection:

- Wounds longer than 3 cm through the full thickness of the skin.
- Wounds to the palm or back of the hand in the area of joints or tendons where there is an alteration of function, or through the full thickness of the skin — these wounds, even though small, may result in damage to underlying structures.
- Wounds that require sutures:
  - Wounds with edges that are jagged and irregular or the flesh is destroyed
  - Wounds with a flap of full-thickness skin
  - Wounds that gape when cleaned and are difficult to close
  - Wounds over joints where skin closures do not stay secure because the skin is mobile or under pressure
  - Facial wounds, which may leave visible scars
  - unless they are very superficial and not under tension
- Wounds that are very dirty (e.g., with ground-in dirt, asphalt, or organic matter) or large contaminated abrasions
- Human or animal bites
- Wounds that have embedded foreign materials, such as glass, metal, or wood
- Burns:
  - Significant second-degree burns covering less than 10% of the body surface (patients with burns to more than 10% are in the RTC)
  - Third-degree burns covering less than 2% of the
  - body surface (patients with burns to more than 2% are in the RTC)

Once the attendant decides to refer the patient to a physician, the patient should get to a medical facility as soon as possible, preferably within six hours.

Ring removal

Injured fingers frequently swell. If the patient is wearing a ring proximal to or near the injury, the swelling may impair circulation in the finger. Rings on fingers near an injury should be removed.

Most patients who have a swollen finger from a contusion, sprain, burn, insect bite, or edema can have their rings removed by simple lubrication of the finger with soap or petroleum jelly. If this does not work, the string method can be used. Wrap the finger with string from the tip to the ring, then insert the string under the ring. The ring is pulled distally as the string is unwound. This method cannot be used where there are major lacerations or the finger is crushed. In these cases, the ring must be removed with diagonal cutters or a special ring cutter.

Wound cleansing

With more serious wounds involving fractures, crush injuries to the hands or feet, or where large amounts of soft-tissue damage are present, cleansing is limited to brushing away the gross contaminants. Involved cleansing procedures will only cause the patient unnecessary pain and delay transport to medical aid.

For less serious lacerations or wounds, when the worker will be returning to work, use the following cleansing procedure:

1. Wounds in hairy areas (scalp, limbs) that will be cared for by the attendant should have the hair cut approximately 1 cm (½ in.) back from the wound edges to facilitate treatment. Do not shave eyebrows, as they may not grow back.
2. The recommended solution to irrigate a wound is comfortably warm, clean, running, potable tap water. Studies have shown that the infection rates of this type of water versus sterile saline are roughly the same. Mild antibacterial, detergent solution (e.g., Savlon®, Hibidil®) may be used for cleansing around the wound, but should be avoided in the wound. Although detergent solutions can damage or kill bacterial cells, they also damage or kill good human cells, impairing immune response and healing. The exception to this process is bite wounds, see below. Do not use the following solutions:
   - Hydrogen peroxide — destroys healthy tissue
   - Alcohol — destroys healthy tissue
   - Iodine — destroys healthy tissue
   - Zephirin hydrochloride — loses potency in storage and becomes unsterile

- Mercurochrome or any other coloured solution — colours the wound, making identification of underlying structures and developing infection difficult

3. Bite wounds are the exception to the soap/detergent guidelines above. Human and animal bites in particular have multiple organism types that can be damaging. Diluted soap or detergent (e.g., Savlon®, Hibidil®) should be irrigated in these wounds. Wild animal bites such as bats and racoons are at risk for rabies, and require soap irrigation to deactivate the virus. Bite wounds at risk for rabies should be referred to medical care.
4. Cover the wound with sterile gauze and hold this dressing over the wound with one hand while cleansing the surrounding skin with the other hand. For cleansing, use sterile gauze dampened with the antibacterial detergent; work outward from the wound and discard the swabs often. Cleanse an area of several centimetres around the wound. Do not use absorbent cotton, cotton-tipped applicators, or paper tissues for cleansing, as shreds of these materials may remain in the wound.
5. Cleanse inside the wound with comfortably warm, running, potable water if available. Gently spread apart the wound and examine it for blood clots and foreign material. Blood clots often contain specks of dirt. If dirt and grime are embedded in the wound, gently remove them using sterile gauze and normal saline (see Figure 29-14 Minor wound cleansing) or comfortably warm potable running water. Do not use antiseptic or detergent solutions to cleanse inside wounds.
6. When the wound is clean, it should be irrigated with copious amounts of comfortably warm, running, potable water or sterile saline.
7. The need for referral to medical aid should be reassessed after cleansing the wound.

Figure 29-14 Minor wound cleansing

Dressing and bandaging of open wounds

1. Use skin closures to hold the wound closed only if the patient is returning to work (see Figure 29-15). These are available commercially in a variety of sizes:
   - To ensure adhesion of the closure, wound edges should be dried and hair removed.
   - Tincture of benzoin (Friar's Balsam) may be applied sparingly to intact skin around the wound to increase the stickiness of the surface. Cotton-tipped applicators are used to apply the compound. Ensure that it does not get into the wound, where it will irritate and burn. Tincture of benzoin takes about a minute to dry.
   - Apply one skin closure at a time, starting from the centre of the wound and working in both directions. Apply half of the skin closure up to the wound margin and press it firmly into place.
   - Close up the skin edges and press the free half of the closure firmly into place. A large skin closure may be applied temporarily to the centre of the wound as a holding device.
   - Apply additional skin closures to complete the closure.
   - If any of the initial closures are incorrectly applied, they can easily be removed and repositioned. To remove a closure, lift the edges on the same side of each flap and gently pull the closure off along the long axis of the wound to avoid straining the other skin closures.

- If a “holding” skin closure is used, it may be removed when the rest of the closures are in place.
- Finally, a strip of adhesive may be laid over all the flaps on each side of the wound. This will lend strength to the closures and increase the surface area being used for adhesion.
- The skin closures should stay in place for 7 to 10 days.

Figure 29-15 Skin closures

2. Apply a sterile dressing large enough to cover the wound, and secure it in place with a bandage large enough to cover the entire wound dressing. Figure 29-16 shows some skin closures as well as some typical hand and finger bandages. Advise the patient to make sure their tetanus immunization is up to date (for clean minor wounds tetanus immunization within the past 10 years is considered adequate; for all other wounds, the immunization should be within the past five years). If immunization is necessary, it should be obtained within 36 hours.

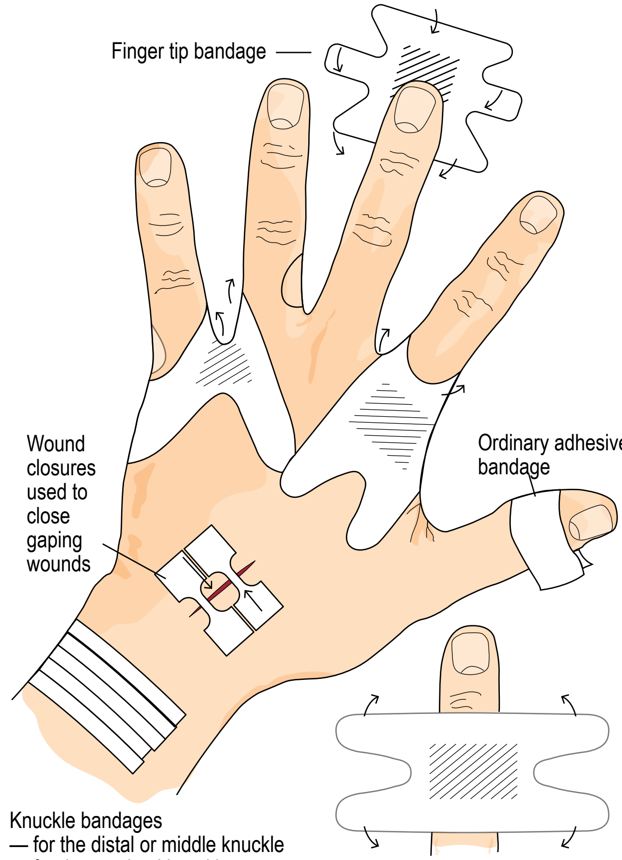

Figure 29-16 Typical finger and hand bandages

3. Instruct the patient on how to care for the wound until it is time to return for follow-up care. The patient may be given a prepared sheet of instructions for the particular injury that explains the necessary care. This may include instructions for:
   - Keeping the dressings clean and dry in order to prevent infection
   - Watching for signs of infection (see page 219, Recognition of Infection)
   - Removing supportive bandages when not actively using the limb (sprains/strains only)
   - Reapplying supportive bandages when sleeping (sprains/strains only)
   - Returning to first aid for reassessment and redressing

Follow-up

The patient should immediately report back for reassessment or redressing if:

- The dressings become wet or soiled
- There is a significant increase in pain in the area
- Tingling or a loss of sensation develops in or distal to the area
- The patient notices signs of infection

Otherwise, the patient must return for follow-up in 24 hours. This could be early the next day if the injury requires the replacement of a support bandage such as a spica bandage for a mild ankle sprain. When the patient returns, the attendant must:

- Check the wound for infection. The dressing should be removed after 24 to 48 hours to check for infection. A small amount of redness and swelling around the wound is part of the normal healing process. Redness, heat, swelling, and increased tenderness are signs of infection. Pus may be present. If there is infection, all the closures should be removed so the wound can drain. It should be dressed and the patient referred to a place of medical treatment. If no infection is found after the first dressing change, the wound should heal well.
- Continue treatment until the wound heals. A healing wound does not achieve its greatest strength for about 2 or 3 weeks. Even after the skin closures have been taken off, a dressing should be used until the wound is 2 weeks old. The dressing must be changed as often as necessary if it becomes soiled or wet. The dressing should be changed to check on progress of healing every 2 days.

The patient should be instructed to keep the dressings clean and dry in order to prevent infection.

Treatment of specific wounds

Puncture wounds

Puncture wounds may appear small on the outside but there may be severe damage inside. When assessing for damage to underlying structures, the attendant must consider the mechanism of injury, depth, location, appearance, restriction of movement, and alteration of function. There is a danger of infection due to the likelihood of contamination below the surface.

Any patient with a penetrating injury to the head, neck, chest, abdomen, or groin is in the rapid transport category. Any patient with a penetration to a joint must be referred to medical aid.

If the patient is able to return to work:

1. Cleanse the wound as outlined on page 214.
2. Soak the wound in warm potable tap water or normal saline or a diluted antibacterial detergent solution for 15 to 20 minutes.
3. Dress the wound.
4. Instruct the patient to continue the warm saline soaks at home three or four times a day for 48 hours.
5. Have the patient return for reassessment after 24 hours.

If the skin is punctured by an object contaminated with blood or bodily fluids (see page 313, Bloodborne Pathogens), or is the result of an animal bite, do the following:

1. Allow the wound to bleed, and then promptly wash the area with sterile saline or clean water and mild soap.
2. Dress the wound.
3. Refer the patient to medical aid promptly.

Foreign objects in wounds

Foreign objects are very common and can be any material. They can vary in size from small slivers and pieces of glass to large impaled objects.

Any sliver, whether wood, metal, or glass, that may have penetrated a joint or gone deep enough into the flesh to damage deeper structures must be immobilized and referred to medical attention.

Wooden slivers

Locating a small wooden sliver is often difficult for two reasons:

1. The sliver may be flesh-coloured and completely embedded.
2. The patient may report for treatment after attempting to remove it.

Locating a small wooden sliver

1. Cleanse the area thoroughly but gently with the antibacterial detergent solution and dry it with gauze.
2. Paint the area with a coloured antiseptic solution (e.g., Povidone or iodine). Allow the area to remain wet for 15 to 30 seconds, and then wipe the colour away with gauze. If the end of the sliver is close to the surface, it will soak up some of the coloured antiseptic and show up as a dark spot.

Metal slivers

This type of sliver enters the flesh:

- While the worker is handling metal materials
- From flying metal, such as a chip that breaks off the head of a chisel when it is struck by a hammer

If metal slivers can be seen and easily removed, they are managed the same way as wooden slivers except that painting the area with a coloured solution is not helpful and can make it difficult to locate the sliver.

Glass slivers

Glass slivers are commonly found in fingers or soles of feet. They are usually invisible to the naked eye and therefore difficult to remove with sliver forceps. After soaking the affected area in a warm, diluted antibacterial detergent solution for 20 minutes, the sliver may be able to be removed with gentle scrubbing. If glass slivers can be seen and easily removed, they are managed as wooden slivers except that painting the area with a coloured solution is not helpful and can make it difficult to locate the sliver.

Removing a sliver

1. Determine the angle at which the sliver entered the skin.
2. Grasp the end of the sliver with a pair of disinfected sliver forceps. Withdraw the sliver along the same angle as it entered.
3. After the sliver has been removed, treat the wound as for a puncture or laceration.

Bleeding that may occur after removal of a sliver can be controlled by direct pressure. If the wound is large enough, it may require referral to a physician for suturing. Small wounds may be treated as previously described.

Fish hooks

If a fish hook is caught in the soft fleshy part of the skin and the point is almost or actually poking through the skin, the hook can be pushed further through the skin and the barb cut off. The remaining portion can then be backed out. If the fish hook is pointing towards deeper structures, the patient should be referred to medical aid.

After the hook has been removed, soak the wound in a warm diluted antibacterial detergent solution for 15 to 20 minutes and apply an appropriate dressing. Instruct the patient to continue warm tap water soaks at home three or four times a day for 48 hours.

Fish hook injuries must be observed carefully for signs of inflammation or infection for several days. The patient should be questioned about whether they had a tetanus immunization within the past five years, and if not, advised to get such an immunization within 36 hours.

Pressure injection injuries

Pressure injections of any foreign material, such as paint, solvents, oil, grease, air, or water, into the body may produce devastating, disabling injuries. Such injuries must be recognized and the patient referred to medical aid. Delays in access to medical care may result in loss of an affected limb. An innocent-looking puncture wound to a finger or thumb may be the only evidence of a substance injected under pressure of 3,000 to 7,000 pounds per square inch (psi). The high pressure of industrial compressors can force the material along tendon sheaths, nerves, and blood vessels. Damage is caused not only by the mechanical force but also by chemical irritation.

Signs and symptoms

- A mechanism of injury involving a pressurized tool
- A small puncture wound, which may ooze grease, paint, or other matter
- Pain in the affected area, especially on movement; however, the onset of pain may be delayed for a
- few hours
- Swelling and/or subcutaneous emphysema

Subungual hematoma

A blow to a finger or toe frequently causes a collection of blood to form under the nail bed. This condition, called a subungual hematoma, may cause throbbing and can be very painful. If the blood is released, the patient feels some relief.

After examining and cleansing the area, the attendant should use eye protection and then release the blood through a small hole in the nail at the centre of the collection of blood. If a nail drill is unavailable, the hole can be made with the red-hot end of an opened paper clip. The nail has no nerve endings so this procedure is painless. A pair of pliers or locking forceps should be used while heating the paper clip and to hold it steady during treatment. The attendant should ensure that the patient’s hand or foot is on a firm surface and the heat source used to heat the paper clip does not pose a hazard.

If releasing the blood does not stop the pain, a fracture of the distal phalanx should be suspected and the patient referred for medical attention. If there is initial relief, but the blood or pressure returns, reopen the hole with a sterilized needle. If the worker is going off shift, they can reopen the hole. The attendant should emphasize the importance of using a sterilized needle.

Patients with crushed distal phalanges or distal finger joint injuries should not be given this treatment. They should be referred for medical attention.

Abscess

An abscess (boil) is a localized collection of pus within the tissues. It is usually found in hair-bearing areas.

Treatment usually involves draining the abscess. This will occur naturally if the abscess is left alone for a few days. The process can be hastened by local application of hot or warm compresses until, after a day or two, the skin bursts, allowing the pus to escape. Once the core is discharged, dry dressings should be applied. Clean the area intermittently with antibacterial detergent solution and gauze swabs as necessary.

Neither the patient nor the attendant should squeeze the abscess. This action is likely to spread the infection to deeper structures.

If an abscess is large or very painful, or involves the face, neck, groin, or buttocks, referral to a place of medical treatment for surgical drainage is indicated.

This also applies if the patient is generally feeling sick, has a fever, or if local measures do not seem to be effective within one to two days.

Wound infection

Inflammation has already been discussed in the section starting on page 206. The term infection applies to an inflammatory reaction resulting from the presence of harmful microorganisms. Infections may be caused by several different types of microorganisms, including bacteria, viruses, fungi, and parasites. Not all organisms are harmful. Many are present normally in different parts of the body, where they perform useful and necessary functions — e.g., to aid digestion in the bowel. However, if these organisms enter another part of the body, they may cause infection — e.g., fecal contamination of a skin wound. Infections can develop in any tissue of the body, from a variety of mechanisms and from many different organisms.

In the course of their work, attendants are most likely to encounter wound infections caused by bacteria.

Bacterial infection

Bacteria are living organisms and need the following conditions to help them survive and grow:

- Moisture
- Nutrients
- Oxygen, although some bacteria, such as tetanus (lockjaw) and gas-gangrene bacteria, live without oxygen
- Warmth — normal body temperature (37°C or 98.6°F) is the best temperature for most bacteria to grow and multiply

Bacteria are found everywhere. Many are capable of producing infection if they enter the body. The intact skin normally serves as an effective barrier to infection but, should the skin become broken due to a wound (e.g., a laceration or abrasion) bacteria can then enter the body. Bacteria can also enter the body by being inhaled through the nose and mouth, ingested through the gut, or through the genitourinary system.

Bacteria can be spread in many ways — especially by fingers and hands. From there, they can be carried to the eyes, nose, mouth, other people, and especially to open wounds.

Bacteria may enter a wound:

- At the time of injury
- After the injury

Bacteria are introduced into the wound both from the object that caused the injury and from the patient's own skin. With open wounds, dirt in clothing may be carried into the deeper tissues of the wound, making bacteria difficult to remove. Materials vary greatly in their capacity to carry bacteria. Metal fragments are usually free of bacteria. Soil and organic matter are usually heavily contaminated.

Bacteria can also be introduced after the injury, by someone who breathes or coughs into a wound or touches it. Unsanitary first aid techniques will contaminate the wound. Poor hygiene and improper handling of the wound dressings can also introduce bacteria.

Recognition of infection

Signs of infection do not appear immediately after the injury because it takes time for bacteria to grow and multiply. Signs may appear as early as one day after injury, or may be delayed for several days. Wound infections (see Figure 29-4 Puncture) may be recognized by:

- Pain and local tenderness around the wound
- Heat around the affected area and, sometimes, fever
- Redness around the area
- Pus beneath the skin or draining from the wound
- Swelling of the infected part and/or the proximal lymph nodes
- Red streaks extending from the area

Signs of fever, swollen and sore lymph nodes, and red streaks extending from the area usually indicate lymphangitis (see page 207, Lymphatic System). A patient with suspected lymphangitis must be examined and treated by a physician as soon as possible.

Treatment

As soon as the attendant suspects a wound is infected, the patient must be referred to a physician.

From the moment of injury, there is a risk of infection and this continues until the wound is healed. Procedures for the prevention of infection are discussed in the chapter on Communicable Diseases starting on page 311.

Tetanus

Tetanus (lockjaw) is a serious infectious complication of a wound. It is caused by infection from bacteria that inhabit the intestines of domestic animals. These bacteria are found in soil and dust, deposited there in animal feces. They are also found in human feces. They grow best in the absence of oxygen, so are most likely to complicate deep wounds that have not been adequately cleaned and have poor drainage.

However, tetanus may occur as a complication in any size or type of wound, from seemingly trivial puncture wounds and abrasions, through lacerations, burns, and compound fractures. Approximately one-third of tetanus patients have an unrecognized wound or one considered insignificant by the patient.

The tetanus bacteria produce a powerful toxin, which greatly increases the irritability of the nervous system. It starts with local spasms in muscles around the wound site, and these may become widespread generalized spasms. The spasms are usually triggered by external stimuli, such as noise, light, touch, or changes in temperature. The stimulus may be minimal, such as a draft or cool air from an open door. Early in the course of tetanus, patients may complain of irritability, headache, low-grade fever, or abdominal- wall muscle cramps. There may be tightness of the muscles of the jaw, which make it difficult to open the mouth — hence the term lockjaw. Spasms of the face muscles may cause a fixed half-smile, and spasms of the throat muscles may make swallowing impossible.

The painful and fatiguing spasms may involve other muscles of the body and are usually separated by periods of relaxation. This leads to progressive exhaustion and death due to mechanical failure of the breathing mechanism, or from cardiac failure.

Signs of tetanus may develop as soon as three days or as late as three weeks following injury. The average time for it to develop is seven days.

Specific treatment is not within the scope of first aid, but the attendant should be able to recognize early signs of the condition. Patients suspected of having tetanus are in the rapid transport category.

Early recognition and rapid transport are very important because once tetanus is established, the mortality rate for this infection is about 40%, even with appropriate therapy.

Prevention

Tetanus can be prevented if all wounds receive proper treatment and all patients with wounds have up-to-date tetanus immunization.

To prevent tetanus from developing, all wounds must be thoroughly cleaned as described on page 214, Wound Cleansing. Each patient with a wound should receive a tetanus toxoid injection as soon as possible after an injury, preferably within 36 hours. This applies to any individual, whether or not there has been a prior immunization, unless a booster was administered within the past 10 years if the patient has a clean minor wound or within the past five years for all other wounds.

Immunization must be given within 36 hours. If medical attention will be delayed beyond 36 hours, it is even more essential that the wound be properly cleaned and dressed.

The patient who is developing early signs of tetanus must be transported rapidly to hospital and must be given supportive care with minimal external stimuli. Ear plugs may be placed in the patient's ears, adequate blankets should be used to keep the patient warm, and the transport vehicle may be darkened. Oxygen may be administered if the patient has respiratory muscle spasms.

Gas gangrene

Gas gangrene, like tetanus, is caused by bacteria that thrive in the absence of oxygen. Wounds involving muscle, especially deep wounds with considerable muscle destruction, poor drainage, and soil contamination, have the highest risk of infection. The earliest signs are usually sudden onset of pain and swelling in an area of wound contamination, with local tissue discolouration, and a brownish foul-smelling watery discharge. This discharge is highly infectious. There may also be a low-grade fever and, sometimes, shock. The most definitive characteristic is the presence of a crackling (crepitus) beneath the skin when the swollen tissue is pressed, due to tiny gas bubbles in the tissues.

The first aid management includes local wound care as outlined previously (see page 213, Management of Minor Wounds). If gas gangrene is suspected, the patient is in the rapid transport category. General supportive care for shock should be provided and oxygen administered.

Necrotizing fasciitis

Necrotizing fasciitis is more commonly known by the public as "flesh-eating disease." The disease got this nickname because it can rapidly spread through human tissue, destroying it at a rate of almost 3 cm per hour. It is caused by a number of different bacteria; one of them is the Group A streptococcus. Researchers do not know why this normally mild bacterium sometimes acts in a destructive way and causes necrotizing fasciitis.

Symptoms include fever, feeling unwell, redness, and severe pain at the site of the infection. The original site of infection may be a minor wound or injury. The infection can spread up the affected arm, leg, or other body part very quickly. An important clue to this disease is very severe pain out of proportion to what would be expected from the type of wound or injury. However, necrotizing fasciitis has also occurred when there has been no known wound or injury.

Chances of getting necrotizing fasciitis are very low; about one or two persons out of every 1,000,000. It is important to remember that even for those who have close, prolonged contact with a person with the disease, the chance of contracting it is very low. Some people are known to have a higher risk of getting necrotizing fasciitis. These people include the elderly, those with chronic heart or lung diseases, injection drug users, alcoholics, very young children or children with chicken pox, and people with diabetes, cancer, HIV infection, or AIDS.

If necrotizing fasciitis is suspected, the patient is in the rapid transport category.

Treatment of major wounds

The treatment of major open soft-tissue injuries is governed by the priority action approach. The general principles outlined below must be followed:

- Control bleeding.
- Prevent infection.
- Immobilize the affected part and keep the patient at rest.

Controlling hemorrhage is the attendant's first priority. Once hemorrhage has been controlled, there may be justification for some wound cleansing. This particularly applies where a wound is grossly contaminated by animal or vegetable matter, such as with wounds sustained in meat and fish packing plants or those contaminated by soil. The risk of infection increases in proportion to the time it takes to obtain medical treatment and close the wound.

Cleansing of major wounds must be limited to brushing away the gross contaminants. It may be necessary to briefly irrigate with sterile saline or tap water. The attendant should not use chemical antiseptics or solvents, which damage or destroy healthy body cells. Further cleansing of major wounds is beyond the scope of the attendant and must be left to the attending physician.

The general principles of management of major wounds

The evaluation and management of the worker with major wounds follows the priority action approach outlined on page 18.

1. Conduct the scene assessment. Activate the workplace emergency response procedures as required.
2. Assess the level of consciousness. Attempt to communicate with the patient. If the patient is not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest. In this situation CPR is initiated according to Part 5, Chapter 13. If there is also obvious massive bleeding at the scene, try to control the bleeding while starting resuscitation. Ask an assistant to help.
3. When the patient is not in cardiac arrest, and any of the following are present on approach, position the patient supine, with cervical spinal motion restriction if the mechanism of injury suggests spinal trauma:
   - The patient has signs of shock.
   - The bleeding is arterial.
   - The bleeding appears massive.
   - Note: External bleeding from the airways is covered on page 60, Unresponsive Partial Airway Obstruction Due to Fluids.

4. Ensure an open airway — with cervical spine motion restriction when the mechanism of injury suggests spinal trauma.
5. If the patient does not respond with clear speech or if their breathing is distressed, but there is massive external visible bleeding, rapidly control the bleeding before moving to ABCs. If the patient responds with clear speech and the bleeding is arterial or appears massive:
   a. Expose the wound and apply direct pressure on the wound.
   b. Protect the injured limb from unnecessary movement.
   c. If the bleeding is arterial and from a limb and does not stop with direct pressure, apply a windlass-style tourniquet to the proximal limb.
6. Assess the adequacy of the patient's respiration and intervene as necessary.
7. Assess the radial pulse and the skin for signs of shock, and conduct a rapid body survey.
8. Apply dressings and bandages to the wound site and if a tourniquet was applied, note the time it was applied.
9. All patients bleeding severely enough to require the use of a tourniquet are in the rapid transport category (RTC). Following the primary survey and initial management of life-threatening injuries, the patient must be transported rapidly to the nearest hospital. Have the helper attempt to maintain support of the injured limb during the move to the stretcher.
10. Reassess the ABCs every 5 minutes for RTC patients or 10 minutes for non-RTC patients. For the urban attendant, reassess the ABCs at 5 minute intervals and vitals at 10 minute intervals. This must now include a check of the bandaged area.
11. Avoid all unnecessary movement or rough handling because such action may restart the bleeding.
12. Conduct a secondary survey. This is done during or while awaiting transport if the patient is in the RTC.
13. Cover any open wound that did not require bandaging during the bleeding intervention with sterile gauze and drainage pads and apply an appropriate bandage.
14. Any objects protruding from the wound should be left in place. The objects may require support with additional dressings (see page 223, Large Embedded Foreign Bodies).
15. When circumstances permit and if movement could restart bleeding, restrict movement of the limb or check the effectiveness of any previous immobilization.
16. Monitor the patient's ABCs every 5 minutes for RTC patients or 10 minutes for non-RTC patients. And monitor vital signs every 10 minutes for RTC patients or 30 minutes for non-RTC patients to determine if there is deterioration. For the urban attendant, reassess the ABCs at 5 minute intervals and vitals at 10 minute intervals.

Management of severed parts

When treating a patient with an amputation, the attendant must be primarily concerned with the ABCs of patient care. However, the attendant must also take steps to keep the severed part viable in case it can be reattached. A well-preserved part may be reattached up to 24 hours after injury. If not handled correctly, the amputated part may only be viable for a few hours.

The following procedure applies to amputations and avulsed flaps of skin and tissue:

1. Find the severed part.
2. As carefully as possible, clean off any gross foreign matter. Pick off any large pieces of dirt but do not scrub the part.
3. Dress the part in sterile gauze, clean sheets, or towels.
4. Moisten but do not soak the dressing with sterile saline. It is important that the amputated part not get waterlogged. Do not place the part in soapy water, formalin, or antiseptic solution.
5. Place the dressed part in a waterproof bag or container and seal it.
6. Place the bag or container inside another container that is filled with ice, preferably, or if ice is not available, cold water. Do not allow the part to freeze.
7. Transport the part with the patient.

Do not compromise patient care. Lifesaving procedures always take priority over management of the severed part.

Crush syndrome

Most industrial injuries are caused by forces acting over a short period of time, such as with a fall, a heavy equipment accident, or an injury caused by a falling object. However, some crushing injuries cause damage to the body as a consequence of force being applied over a relatively long period. In addition to direct soft-tissue damage, continued compression of the muscles and skin will cut off circulation, leading to further tissue destruction. This type of injury is seen most often when the person is trapped with the limbs compressed for several hours — e.g., in mine cave-ins, rock slides, or collapsed buildings. Individuals whose legs are caught under heavy weight will continue to suffer tissue damage until their legs are freed.

In tissues compressed this way, the cells become impaired and begin to leak watery fluid into the surrounding tissue. If the swelling is excessive, the resulting tissue pressure may compress already compromised blood vessels, leading to hypoxia and acidosis in the tissue, causing local cell death.

A syndrome is a set of symptoms or signs that occur together. The classic crush syndrome is a shock state caused by the prolonged compression injury and resultant generalized swelling, which may lead to kidney failure and death if not treated quickly and appropriately in a hospital.

The crush patient may seem to be uninjured when extricated. If possible, the attendant should obtain a history of the duration of compression. If the victim has been trapped for two hours or longer, they most likely will complain of initial pain in the affected part, followed by numbness. Some patients are unable to give an adequate history due to the severity of associated injuries. It is imperative to conduct a thorough examination, especially if there may be delays in transportation to hospital. As soon as the grime has been cleared away, look for patches of reddish skin, which indicates the area of compression. The victim's whole body must be examined for swelling, loss of sensation, pain on passive movement of muscle groups, and loss of power. In most cases the limbs are involved, but areas of pressure can also occur on the buttocks, trunk, or neck. The reddish areas may progress to blister formation, which can be mistaken for a burn. Lacerations, dislocations, and fractures may also be present.

Soon after it is released from compression, the affected limb becomes swollen and tense. The muscle is insensitive and paralyzed, and superficial skin sensation is lost, usually in a patchy distribution. Later, the limb may go cold and blue and become pulseless. Patients with such injuries are often in shock. Severe thirst, generalized swelling, and an elevated temperature may also be present.

Upon completion of the primary survey, and after attending to any life-threatening conditions, the attendant should treat the patient as outlined for shock on page 101. These patients are in the rapid transport category.

The injured limb should be moved as little as possible. Cold should be applied to decrease the rate of tissue and cell breakdown. Cold is applied for up to 20 minutes and removed for 5 minutes, then reapplied. Cold may also help living tissue to survive despite a low blood supply.

Immobilization may be useful to help delay absorption of the harmful muscle breakdown products.

Large embedded foreign bodies

Large embedded foreign bodies should be removed only by a physician. When confronted with a patient with a large embedded foreign body, the attendant must follow three general principles of management:

1. Do not move or alter the position of the foreign body. Attempt to control bleeding with direct pressure around the wound. If bleeding is not controlled with direct pressure, a tourniquet should be used.
2. Quickly stabilize the foreign body. Patients with penetrating injuries of the head, neck, chest, abdomen, and groin are in the rapid transport category.
3. Comfortably restrict movement of patients with large embedded foreign bodies, who are in the rapid transport category, on a well-padded stretcher, with appropriate stabilization of the protruding foreign body. The attendant may have to shorten a very long object to facilitate transport. In these cases, the foreign body must be stabilized before it is shortened.

Occupational dermatitis

Dermatitis is inflammation of the skin. Many people who have never before experienced “skin trouble” may develop some form of dermatitis relating to their work environment.

The most commonly encountered type of occupational disease is dermatitis. Most occupational skin disease results from contact with a chemical substance, of which hundreds of thousands are in common use today.

Chemicals can affect the skin in two ways:

- They can act as a direct irritant (primary irritant).
- They can cause an allergy.

Primary irritant contact dermatitis is by far the most common, making up about 75% of all occupational skin disease.

Signs and symptoms

A history of contact with a chemical may be the only way to determine if the condition is dermatitis. A history of pre-existing skin problems will also help the attendant identify dermatitis.

The first symptoms are usually redness, irritation and occasionally swelling. The patient may complain of itchiness and sometimes pain. Blistering, to the point of weeping, may occur. Thickening and fissuring (cracking) may develop later. Superimposed bacterial or fungal infection can complicate the underlying condition. With long-term exposure, some substances are known to be carcinogenic (cancer-causing).

Any part of the body that comes into contact with a chemical substance can be affected. Usually, the hands and forearms are affected, but an airborne agent such as dust or mist can cause inflammation of the face, neck, or other exposed areas. The belt area and anterior thighs adjacent to the pockets may also be affected.

Dermatitis is not contagious, unless infected, but can spread to other parts of the body if left untreated.

The correct treatment, started early, is essential to the control of dermatitis.

Primary irritants

A skin irritant is any substance that damages the skin by direct contact rather than by allergy.

Virtually any substance can be an irritant under certain circumstances, depending on a variety of factors that include the susceptibility of the individual and the circumstances of contact — such as the concentration of the substance and the length of time the individual was exposed.

Acids and alkalis are examples of primary irritants.

Sensitizers

Sensitizers do not affect everyone, only individuals particularly susceptible to them. To develop an allergy to something, a person must have been exposed to the substance at least once previously. The body then develops an immune response, and the person becomes sensitized to the substance. The person probably will not be aware of becoming sensitized Once an individual has become sensitized to a substance, they probably will remain so and can have an allergic reaction following any subsequent exposure to the substance. Also, it is not unusual for the reaction to occur with progressively smaller amounts of the sensitizer with each subsequent exposure. The sensitivity may also develop with exposure to other chemicals of a similar nature. The allergic reaction (e.g., rash) can appear in a few minutes or as long as five days after exposure.

Other individuals may exhibit sensitivity initially, only to develop a tolerance over time; eventually they may not react to the sensitizing agent at all.

Latex is an example of a sensitizer common in the health care field. Many attendants and patients have an allergic reaction to disposable latex gloves and a non-latex alternative should be used in such cases.

Patients can also have a reaction to latex products such as oral airways or pocket masks. Silicone alternatives are commercially available.

Some substances can be both an irritant and a sensitizer.

Chemical causes of dermatitis

The following groups of compounds are the main causes of industrial dermatitis:

- Mineral oils
- Solvents
- Other chemical groups
  - Acids and alkalis
  - Oxidizing or reducing agents — e.g., hydrogen peroxide
  - Protein precipitants — e.g., formalin
  - Allergens — e.g., nickel, or chromium

Mineral oils

Mineral oils often cause “oil acne” (blackheads and pimples) wherever there is frequent contact with oil and oily clothing, due mainly to the blocking of hair follicles by dirt. Normal skin function is prevented and inflammation follows. The next stage is likely to be infection.

The condition can worsen through prolonged contact with mineral oils. The presence of wart-like or other swellings, ulcers, and sore patches that do not heal can be early warning signs of cancer and should be checked by a doctor.

Covered parts of the body may be affected as well as exposed areas such as the hands and face. Workers should understand the importance of protecting the skin in their genital areas from contact with the oil.

In the early stages, such conditions respond well to treatment with little personal inconvenience or time lost from work. However, treatment must not be delayed.

The dangers of and precautions for mineral oils apply to workers who come in contact with pitch, tar, and some of their derivatives. Furthermore, some of those substances are known to be carcinogenic.

Solvents

Solvents like kerosene, turpentine, acetone, and trichloroethylene remove natural oils from the skin, leaving it vulnerable to damage. It may take several hours or longer to replace the natural surface coating removed by solvents. Long periods of immersion in water-based fluids can also weaken the protective action of the skin.

Prevention of occupational dermatitis

It is far easier to prevent occupational dermatitis than to cure it, but effective prevention requires full co-operation between management and workers.

To make the workplace safer, wherever a material in use is known to be harmful, every effort should be made to eliminate it or to switch to a safer substance.

Despite all the precautions taken to provide a safer working environment, contact with dermatitis-causing substances will still be necessary in certain industries. Workers must be protected with suitable apparel. The importance of personal cleanliness cannot be overemphasized in the prevention of dermatitis.

A guide to personal protection

The following guidelines are designed to eliminate contact, where possible, between irritants and the skin, and to outline the appropriate care for skin that has been exposed.

Personal cleanliness

Personal cleanliness is vital to the prevention of occupational dermatitis. It is extremely important to remove all dirt and contaminants from the skin at the end of the workday, as well as before breaks — e.g., before eating or smoking.

The employer must provide effective cleansing facilities wherever substances are a hazard, and workers should use those facilities.

For maximum protection against dermatitis, workers should do the following:

- Use the cleanser or soap provided.
- Rinse thoroughly with running water.
- Dry completely with clean towels or with hot air dryers.
- Use baths or showers when provided.
- Where possible, change clothing (including socks and underwear) at the end of the day, preferably at the workplace.
- Ideally, have all contaminated work clothing washed professionally. If it is washed at home, work clothing must be laundered separately from the family’s clothing and other laundry.
- Always wash hands before and after using toilet facilities.
- Don’t smoke cigarettes when there are contaminants on your hands.

Selecting cleansing agents

Washing with soap and water is simple and usually sufficient. The quality of the soap is important.

A good-quality super-fatted soap (liquid, gel, or tablet) that lathers well is safe and adequate, but some soaps and domestic detergents can be harsh on sensitive skin. Some popular face and bath soaps are not pure soap at all but non-fatted chemical detergent. Dermatologists have found this soap to be particularly damaging to irritated skin and sometimes even to normal skin. Soap may not always be enough to cope with deeply ingrained dirt and water-repellent substances like paint and tar.

Special skin cleansers, usually in gel form, have been developed to control dermatitis by keeping the skin healthy. The gel is rubbed in well to loosen all dirt and then washed away in running water. Waterless skin cleansers are available for use where there is no water supply. Liquid and gel skin cleansers and creams should be in specially designed dispensers, to reduce the risk of cross-infection.

Conditioning cream should be applied at the end of the workday, especially when the work activity or frequent washing tends to remove the skin's natural secretions.

Avoid the use of solvents such as methyl hydrate, kerosene, paint thinners, and acetone. They remove too much of the skin's natural oils and they, too, can cause dermatitis. Repeated use of coarse abrasives (pumice stone or dry powders) can also be harmful to the skin.

Protective clothing

Depending on the nature of the job, protective clothing, appropriate to the chemical being handled, can include overalls, aprons, gloves, footwear, leggings, and face shields. Such clothing should protect exposed skin and the worker's own clothing, which may absorb a chemical and prolong the skin's exposure to it.

The following advice can be given to workers who are exposed to dermatitis-causing substances:

- Wash all clothing frequently. There is no point in washing the skin thoroughly, then covering it with a contaminated coverall.
- This is especially important for those who work with mineral oils. Prolonged contact with oily materials may result in cancer of the skin.
- Wash protective clothing frequently.
- Regularly inspect all protective apparel for excessive contamination, holes, or worn areas. This especially applies to gloves, which wear out quickly.
- Non-fabric gloves, such as those made of rubber, PVC, and neoprene, should be used only when necessary or as recommended for specific chemicals. They provide no ventilation and they can cause irritation.
- Never change into oil-stained coveralls.
- Do not put oily rags into pants pockets; they may affect the skin underneath.

Barrier creams

Where protective clothing cannot be used and exposure to an irritant is unavoidable, protect the skin with a barrier cream. The cream will shield the skin from contact with the hazardous substance and make cleansing easier. However, other preventive measures should still be taken, even though a barrier cream is used.

It is important to choose the correct cream for a particular situation, because some creams promote rather than hinder absorption of certain substances. A safety equipment supplier or industrial supply house should be able to advise the employer on the proper cream.

When using barrier creams, do the following:

- Be sure the skin is clean and dry before applying the cream.
- Remove the cream by washing after each work session, and before meal time, going to the washroom, and coffee breaks.
- Apply fresh cream to clean skin to provide
- continuous protection.
- Read and follow the manufacturer's directions.

Management of dermatitis

For serious skin injury resulting from highly caustic or irritant chemicals, see page 305, Poisoning by Skin Contact, and page 281, Management of Chemical Burns.

Injuries or dermatitis, however minor, should be protected with a suitable dressing. Persistent (three or four days) signs of skin irritation of any kind should be referred to a physician. Early advice and treatment can prevent a minor case from becoming serious and will reduce the likelihood of long-term disability. It may also reduce the chance of a recurrence for those who cannot completely avoid exposure to an offending agent.

Hives (urticaria)

Hives are a common skin reaction, affecting as much as 20% of the population at some time during their lives. It can be considered a skin response to exposure to a substance to which a person is allergic. Although allergy is not invariably the cause of hives, it is by far the most common cause the attendant is likely to encounter.

Exposure to the allergen may occur by several routes:

- Direct contact
- Inhalation
- Ingestion
- The response may be:
- Localized — e.g., as with a mosquito bite
- Generalized — e.g., as with a drug reaction

Other, rarely encountered causes of hives include certain types of infection, cancer, sunshine, scratching, and even emotion.

Signs and symptoms

- Raised, reddened, swollen areas with sharply defined map-like borders
- A diameter that can range from less than a centimetre to several centimetres
- Intense itching or a prickly sensation
- Chest tightness, wheezing, and cardiovascular collapse (anaphylaxis) (see page 288, Allergic Reaction)

Treatment

Local

- Cool compresses
- Antipruritic (anti-itch) lotions (e.g., calamine, oatmeal)

Oral

- Antihistamines (e.g., chlorpheniramine, astemizole, terfenadine) (see page 199, Non-Prescription Drugs and Medications)

Injection

- Adrenalin and epinephrine — to be used only in case of anaphylaxis

Activity-related soft tissue disorders (ASTDs)

A soft tissue injury that is caused by, or that is aggravated by activity, is referred to by WorkSafeBC as an activity related soft tissue disorder (ASTD). ASTDs refer to a group of disorders affecting these tissues, where activities at work or elsewhere (e.g., domestic and sports activities, hobbies) may expose an individual to a number of risk factors for the condition. Other commonly used terms for this group of disorders include cumulative trauma disorders and repetitive strain injuries.

Soft tissues such as muscles, tendons, bursae, nerves, and blood vessels can become inflamed as a result of:

- Chronic, excessive activity (overuse)
- Infection
- Direct trauma

Risk factors

The attendant will frequently encounter soft-tissue inflammatory conditions related to activities at work. The factors that determine whether a condition develops are related to the activity itself, to the environment in which the activity is carried out, and to the particular individual involved.

Risk factors related to the activity include:

- Repetition — whether the activity requires the repetitive use of the same soft tissues
- Frequency — how often the work cycle is repeated, as well as the amount of time in each cycle spent performing the activity compared to the amount of time in the cycle spent recovering
- Duration — the total amount of time spent performing the activity (e.g., total hours or percentage of the workday)
- Force — the effort or load on the tissues from performing the activity
- Posture — whether the activity involves awkward postures, where joints are near or at the extremes of their range of motion, or where muscle tension is required to hold the posture
- Static load — whether during the activity the tissues are held against gravity or some other external force
- Unaccustomed activity — where the worker is new to the job or has recently returned to work after an absence (e.g., vacation, illness, other injury) or where there has been a recent change in job function (e.g., different tasks) or production (e.g., overtime, work pace, rest breaks)
- Contact stresses — where there is physical contact between soft tissues and objects
- Impact loading — whether during the activity the tissues must resist kickback from a power tool (e.g., nail gun) or the worker uses the hand as a hammer
- Vibration — whether there is hand-arm vibration from equipment such as pneumatic tools or chainsaws
- Temperature of the ambient environment, particularly cold

The greater the number and extent of these risk factors, the more likely it is that a soft-tissue injury will develop.

Risk factors related to the individual include:

- age
- sex
- smoking
- pregnancy
- some medical conditions — e.g., arthritis, diabetes
- physical fitness
- alcohol and/or drug use

Tendinitis/tenosynovitis and bursitis

Definitions

A tendon is a band of strong white fibrous tissue that connects a muscle to a bone. It is often surrounded by a sheath of specialized tissue called the synovial sheath, which lubricates the tendon and allows it to glide smoothly through the surrounding sheath.

A bursa is a sac-like cavity lined with a slippery synovial tissue. Bursae are located at sites of potential friction between tendons and muscles and bony prominences lying beneath them. Their purpose is to reduce friction between the tissues, thereby reducing wear and tear on the tendons and muscles.

Inflammation of the tendon (tendinitis) and of its synovial sheath (synovitis) often occur simultaneously (tenosynovitis). For the purposes of the attendant, tendinitis and tenosynovitis can be considered the same condition. They may also be confused with bursitis (inflammation of the bursae). This confusion is because the tendons, their sheaths, and the bursae are often situated close to one another anatomically, and the symptoms and signs may be identical.

History

For occupational tendinitis and bursitis, the worker will give a history of work activities that include some of the risk factors mentioned previously.

Signs and symptoms

The clinical presentation of tendinitis and bursitis is so similar that it is often difficult to differentiate between them. Signs and symptoms may include:

- Pain — especially with movement; may radiate
- Swelling
- Redness
- Warmth
- Crepitus — a grating, crackling, or popping sound or sensation palpable over the involved tissues, with minimal movement
- Tenderness — along the course of the affected tendon or over the affected bursa

The signs of tendinitis and bursitis are similar to infection (cellulitis). The presence of fever indicates infection. Early referral to a physician is indicated because it is extremely important not to delay treatment of an acute infection in or near a joint.

Workers should be aware of these symptoms and be encouraged to report them when they begin, so that early treatment and intervention can minimize disability. Otherwise, workers may continue working until their injuries become so severe that further work is impossible.

The attendant should suspect an ASTD when a worker whose job has some of the previously outlined risk factors has signs and symptoms listed in Table 31-1.

Management

- Thoroughly assess the worker as outlined on page 193, The priority action approach to the Walk-In Patient.
- Rest the part. Mild cases of tendinitis and bursitis will often recover spontaneously with a few days of resting the part or with a temporary change in work activities.
- Apply cold for up to 20 minutes, every one to two hours.
- Encourage the patient to wear a wrist brace when sleeping (see Figure 31-1 Wrist brace).
- Reassess the patient daily for any changes in condition (e.g., in pain, job function, neurologic status).
- If the patient has significant pain, restricted range
- of motion in more than one direction, swelling or crepitus, refer to medical aid.

Figure 31-1 Wrist brace

Referral to medical aid

Refer the patient to medical aid if:

- The patient initially reports with significant pain,
- swelling or crepitus, and limited range of motion
- The daily reassessment shows deterioration in the patient's condition
- There is no improvement after three days of resting the part
- An infected joint or bursa or cellulitis (increasing pain, spreading redness, fever) is suspected

Physiotherapy and medication (e.g., antibiotics for infections, aspirin, anti-inflammatories, or steroid injections) may be prescribed by the physician. The physician may want to involve the attendant in treating and monitoring the worker upon their return to work.

Examples of tendonitis and bursitis		
Location	**Tendonitis**	**Bursitis**
Hand/wrist	• Extensor/flexor tendonitis — pain with extension or flexion of fingers or wrist • De Quervain's tendonitis — pain with use of wrist or thumb on the thumb side of wrist • Trigger finger — a snapping movement of a finger due to swelling and restricted gliding of the flexor tendon as it catches and then releases	
Elbow	• Epicondylitis, lateral — tennis elbow — or medial — golfer's elbow — inflammation of the tendons where they attach to the bone at either side of the elbow — epicondyles	• Olecranon bursitis — swelling over the point of the elbow
Shoulder	• Various tendons and/or bursae in the shoulder region can become inflamed • Bicipital tendonitis — pain in the anterior shoulder upon flexion of the shoulder or elbow	
Hip		• Trochanteric bursitis — pain on the lateral aspect of the hip
Knee	• Patellar tendonitis — tenderness just distal to the patella anteriorly and pain with kneeling or upon knee extension	• Prepatellar or suprapatellar bursitis — pain and swelling in the knee
Foot/ankle	• Achilles tendonitis — tender heel cord posteriorly, with pain on walking	

Table 31-1

Nerve entrapment syndrome

Nerve entrapment syndrome is characterized by compression and entrapment of peripheral nerves at a variety of sites. The most commonly encountered condition is carpal tunnel syndrome — median nerve compression at the wrist.

Carpal Tunnel Syndrome

Carpal tunnel syndrome (CTS) is caused by compression of the median nerve at the flexor side of the wrist as it passes into the hand. Typical symptoms include:

- Numbness, tingling or burning of parts of the thumb and index, long, and ring fingers
- Pain and occasional muscle weakness of the thumb
- Pain which may radiate up the forearm
- Pain in the area at night

The condition often arises spontaneously but certain work activities may cause symptoms. It is more likely to occur when the work involves frequently repetitive, forceful movements of the affected wrist and hand, or when the worker is unaccustomed to the activity. When work is a factor, the onset is rapid, and only the dominant or exposed side is affected. In some cases of CTS there may be exposure to vibrating equipment.

In milder cases, the symptoms can come and go over a period of many months and can be managed the same as for tendinitis.

For worsening, recurrent, or persistent symptoms, refer the patient to a physician. Treatment may include rest, splints, and medication. In rare cases, surgery may be indicated.

Hand-arm vibration syndrome

In industries where vibrating tools are used regularly over a period of years (e.g., forestry, hard-rock mining) a condition known as hand-arm vibration syndrome (HAVS) can arise. Other terms for this condition are vibration white finger and white-finger disease.

The worker will experience sudden, repeated, painful blanching of the fingertips, usually of both hands and precipitated by cold weather. This is due to interference with the blood supply to the fingers as a result of arteriolar spasm of the digital arteries. The condition tends to progress gradually over several years, when there is continued exposure to vibration.

There is really no effective treatment available, other than to eliminate or minimize exposure to vibrating tools and to cold.

Prevention of activity-related soft tissue (ASTD) injuries

Prevention of ASTD injuries should be aimed at minimizing the magnitude and intensity of the risk factors of work activity. Some potential control options for these factors include the following:

- Automate highly repetitive tasks.
- Eliminate unnecessary work steps — e.g., move bar codes to the outside of books so books do not need to be opened and closed to scan them.
- Provide workers with well-maintained, appropriate
- tools, equipment, and clothing to eliminate or reduce force requirements, awkward postures, static loading, contact stresses, impact stresses, and vibration.
- Use power tools and touch-sensitive controls or buttons to reduce muscle work and force requirements.
- Use tools with angled handles or redesigned tools so workers do not have to bend their wrists (see Figures 31-2 and 31-3).
- Use tool balancers to support the weight of heavy tools and reduce static loading (see Figure 31-4).
- Alter working heights and angles to reduce awkward postures and static loading (see Figure 31-5), and provide height-adjustable work stations that allow workers to set to their own requiremen0ts (see Figure 31-6).
- Round and/or pad the edges of work surfaces to reduce contact stresses.
- Ensure that proper tools are readily available to do the job so workers do not use their bodies as tools — e.g., use their fists as hammers.
- Use damping materials to reduce vibration.
- Increase or vary the work tasks performed by each worker to involve the use of different soft tissues, or rotate workers between work tasks to decrease the time spent in any one activity.
- Train new workers in proper safe work techniques.
- Allow workers time to become accustomed to new work activities.
- Encourage rest breaks and micro pauses to relax or stretch soft tissues.
- Minimize overtime, or decrease the frequency of the work activity or the work pace.

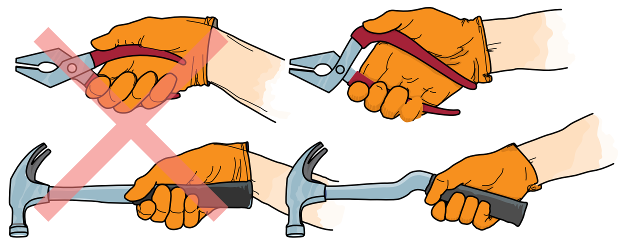

Figure 31-2 Tools with angled handles

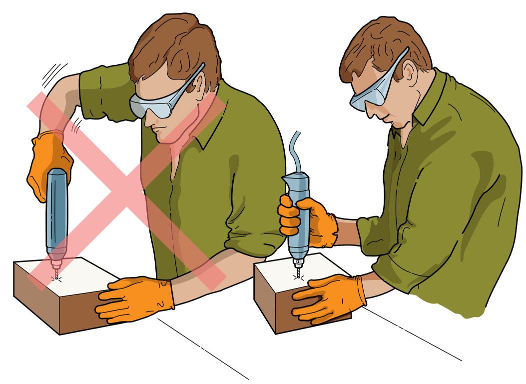

Figure 31-3 Redesigned tools

Figure 31-4 Tool balancers

Figure 31-6 Height-adjustable work stations

Figure 31-5 Alter work heights and angles

Part 10

Skeletal System

Part 10 Skeletal System

Anatomy and function of the skeletal system

Humans rely on a sturdy internal frame that is centred on a vertebral column or spine. The adult skeletal system consists of 206 bones, cartilage, ligaments, and tendons and accounts for about 20% of the body weight. Understanding the skeletal system and its function when assessing an injured worker is very important for an attendant. This chapter provides an overview of the human adult skeleton.

Skeleton

The skeleton is the bony framework of the body (see Figure 32-1). The skeleton's function is to give shape, strength, and rigidity. It protects organs and acts as a movable framework so that muscular contractions can move the body. The framework of the skeleton allows an erect posture against the pull of gravity and gives form to the body.

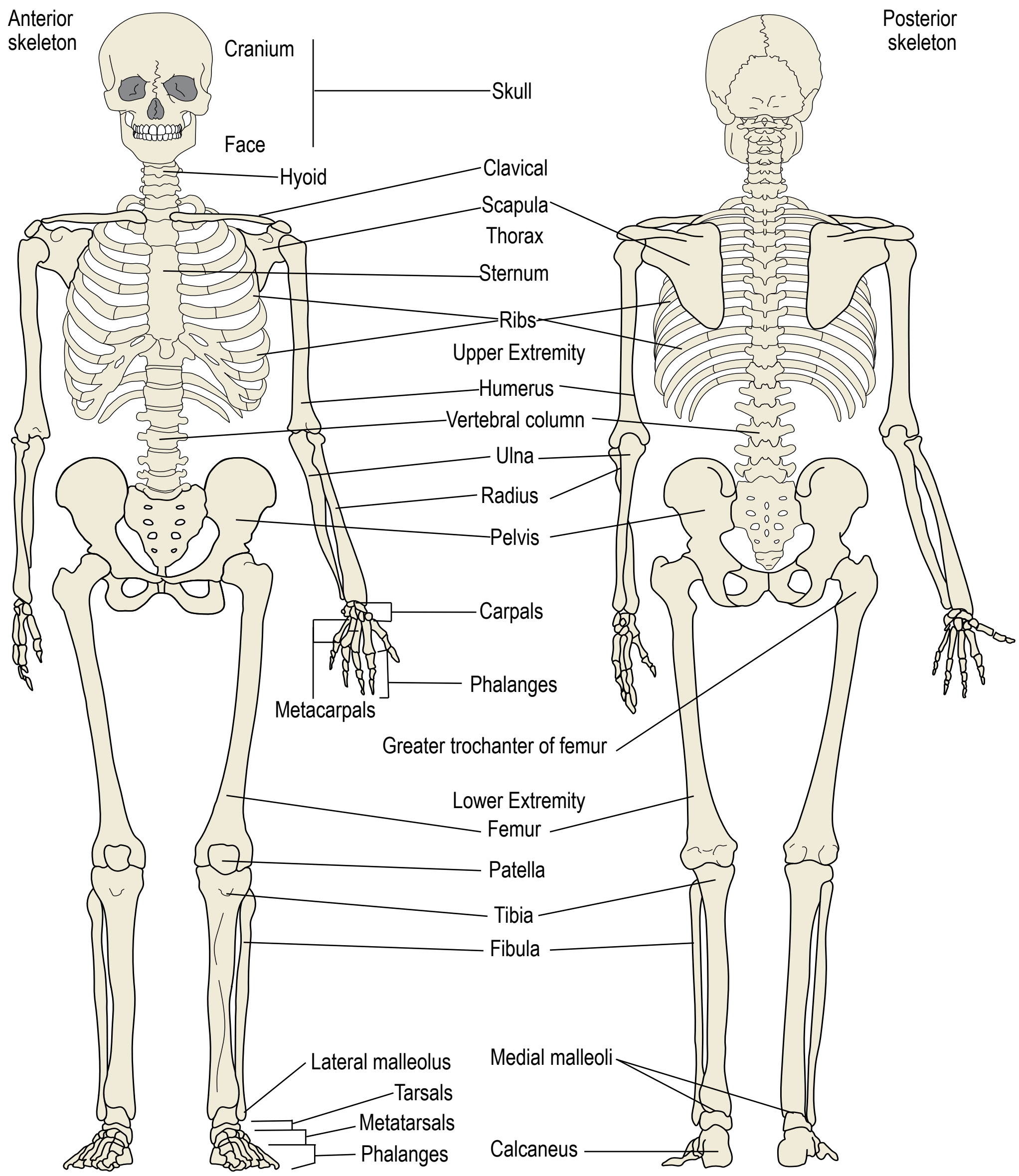

Figure 32-1 The skeleton

Bones are living tissue, like muscles and skin. Most bones have a central hollow space called the medullary cavity. It contains a fatty substance called bone marrow, involved in the formation of blood cells. The outer hard shell of the bone is the cortex. The external surface of all bones is covered by a layer of connective tissue, the periosteum. It is very rich in nerve endings and very sensitive to trauma. Blows to bone are usually very painful. Bone ends are covered with very smooth tough connective tissue, the articular cartilage.

Joints

To permit movement of the body as a whole or in part, many bones are connected by joints.

A joint consists of the ends of two or more bones and the surrounding connecting and supporting tissues.

Ball-and-socket joints, such as the hip and shoulder, are the most mobile. Hinge joints, such as the knee, permit free movement in a single plane. Pivot joints permit rotary movements, such as when the proximal end of the radius pivots around the ulna.

Joints are held together by a capsule and supporting ligaments, which are bands of tough fibrous tissue. Muscles and their tendons pass around and across joints. The joint is enclosed in a fibrous articular capsule. This capsule is lined by a synovial membrane, which secretes synovial fluid, lubricating the joint (see Figure 32-2 Joint structure).

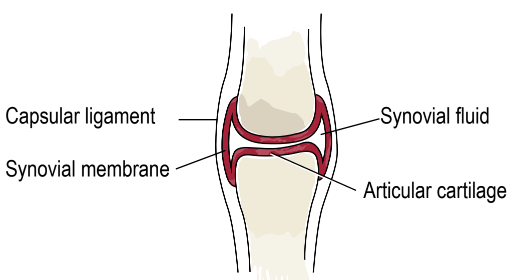

Figure 32-2 Joint structure

Head

The bones of the head are:

- the skull, which forms the cavity containing the brain
- the facial bones

Skull

The bones of the skull consist of two hard layers and a sponge-like, bony core. This gives the skull great strength in proportion to its weight. The dome-like shape of the skull also contributes to its strength. An infant's skull is made up of separate bones, which eventually fuse.

The large bone forming the forehead is the frontal bone, and the large bone forming the back and base of the skull is called the occipital bone (see Figure 32-3 Bones of the face and skull). The foramen magnum, a large opening through which the spinal cord passes, is in the occipital bone. The top and sides of the skull are made up of the parietal and temporal bones. The floor and anterior portions of the skull have a number of small openings for vessels and nerves.

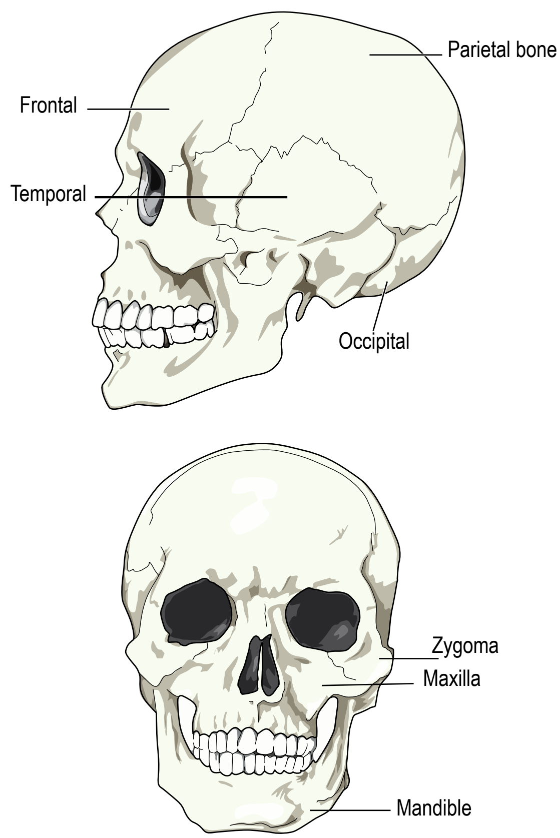

Figure 32-3 Bones of the face and skull

Face

The face is made up of multiple bones, including the zygoma or cheek bone, the maxilla or upper jaw, the mandible or lower jaw, and the nasal bones (see Figure 32-3 Bones of the face and skull). Most of these bones are fused together. The mandible is the only movable facial bone.

Spinal column

The spinal column serves two purposes:

1. it supports the head and upper part of the body
2. it provides rigid protection for the spinal cord

The spinal column is made up of 33 individual bones called vertebrae, separated from each other by pads of cartilage called intervertebral discs. These discs not only serve as cushions between each vertebra but also allow for movement of the spinal column.

Individual vertebrae consist of a body, which supports weight, and an arch, through which the spinal cord passes. Each vertebra has a spinous process projecting posteriorly and two transverse processes projecting laterally. Ligaments and muscles are attached to these projections.

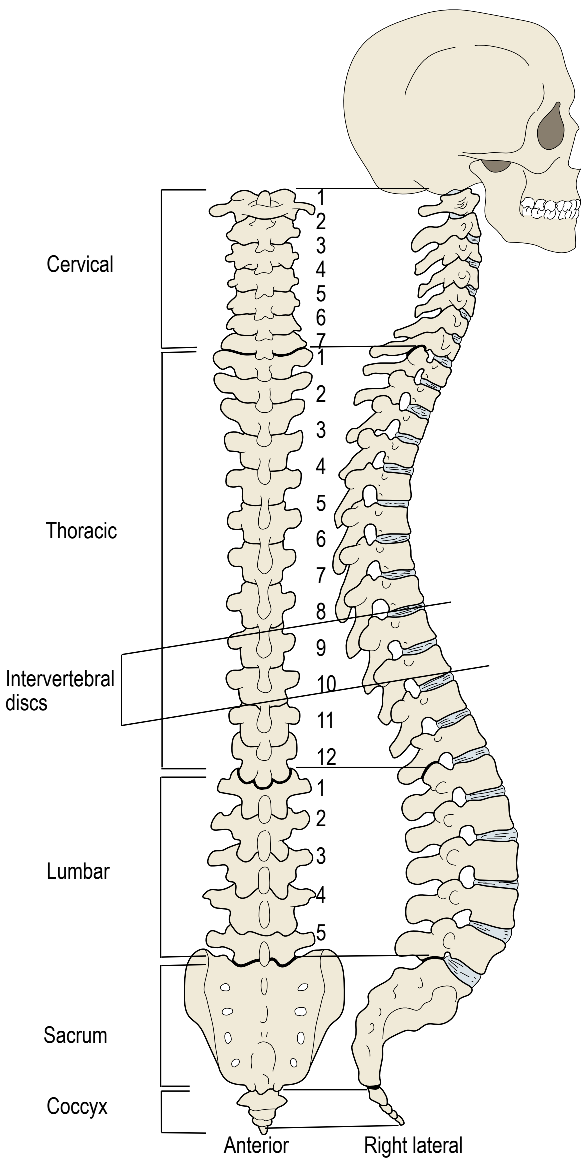

Figure 32-4 Vertebral column

In the neck, at the upper end of the spinal column, are 7 slender cervical vertebrae. Below these, 12 more heavily constructed thoracic vertebrae form the upper part of the back. Below the thoracic vertebrae are 5 more massive lumbar vertebrae, which form the lower part of the back and carry the weight of the upper body. Below is the sacrum, which is part of the pelvis and consists of 5 fused vertebrae. Just below the sacrum are 4 fused vertebrae called the coccyx, or tail bone (see Figure 32-4 Vertebral column).

Thorax

The thorax is formed by the thoracic vertebrae, the ribs, the costal cartilages, and the sternum (see Figure 32-5 The thorax). The thorax protects the heart, thoracic blood vessels, lungs, spleen, liver, and kidneys. The diaphragm forms the floor of the thoracic cavity and the roof of the abdominal cavity.

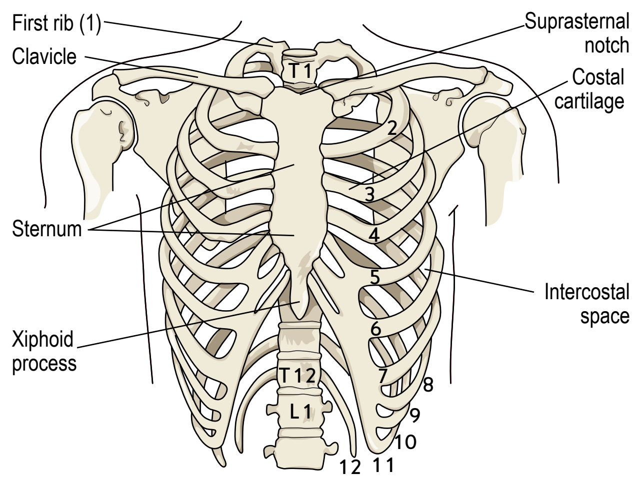

Figure 32-5 The thorax

Ribs

There are 12 pairs of ribs, which are long, slender, curved bones. The ribs articulate with the thoracic vertebrae posteriorly and curve around anteriorly to form the rib cage.

The first 7 ribs are attached to the sternum by the costal cartilages. Each of the 8th, 9th, and 10th pairs of ribs is attached to the cartilage of the pair above. The 11th and 12th pairs of ribs do not attach to any bones at all in the front. They are called floating ribs.

Sternum

The sternum, or breast bone, is a thin, flat bone located in the anterior part of the thorax, along the midline of the body. The sternum is approximately 18 cm (7 in.) long and 5 cm (2 in.) wide. The xiphoid process is the small protrusion at the inferior part of the sternum.

Upper extremities

On each side, the upper extremity includes the shoulder joint, upper arm, elbow joint, forearm, wrist, and hand (see Figure 32-6 Right upper extremity).

Shoulder

The shoulder is formed mainly by the clavicle (collar bone), scapula (shoulder blade), and the upper end of the humerus (see Figure 32-1 The skeleton). These bones and their muscular attachments are called the shoulder girdle.

The clavicle can be felt anteriorly just above the thorax. It is the slender, curved bone forming the anterior part of the shoulder. The clavicle joins with the sternum medially and with the scapula laterally.

The scapula is a flat, triangular bone supported against the rib cage posteriorly by large muscles. The upper and lateral part of the scapula forms the socket of the shoulder joint, which is a ball-and-socket joint. Muscles pass from the scapula across the shoulder joint to the arm.

Upper arm

The upper arm has only one bone, the humerus. The proximal end of the humerus is ball-shaped and fits into the socket of the scapula at the shoulder joint. The distal end of the humerus forms the upper half of the elbow joint.

Elbow

The elbow is a hinge joint. It is formed by the distal end of the humerus articulating with the proximal ends of the ulna and the radius.

Forearm

The forearm consists of two bones, the radius and the ulna. The proximal end of the ulna forms one half of the elbow joint, and the distal end acts as a pivot around which the radius moves when the forearm is rotated. The proximal end of the radius is joined to the ulna below the elbow joint. The larger, distal end of the radius forms part of the wrist joint. The ulna is on the little finger (medial) side of the forearm when the forearm is in the anatomical position. Conversely, the radius is on the thumb (lateral) side of the forearm when the forearm is in the anatomical position.

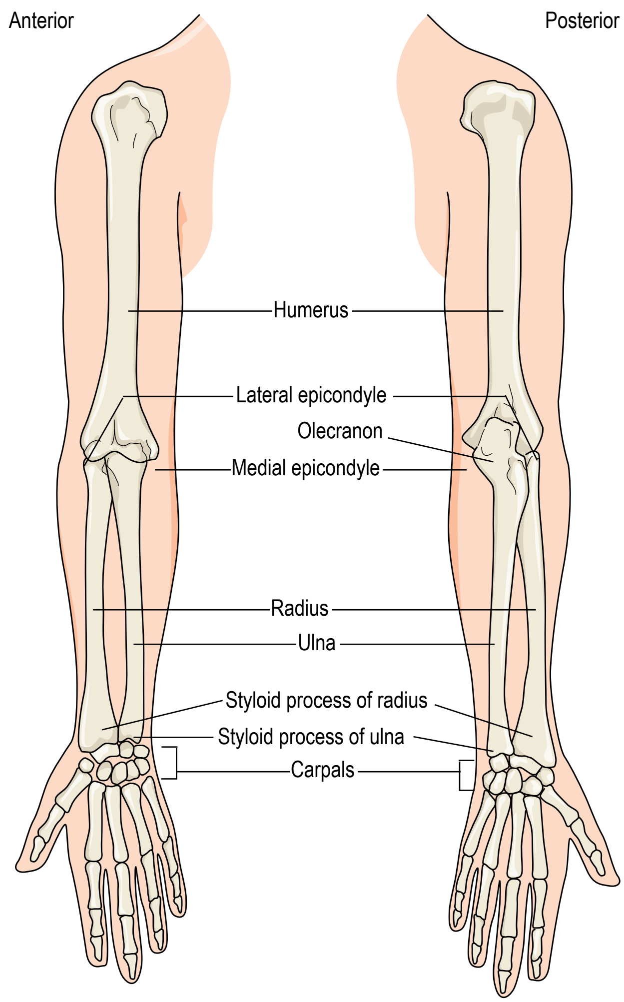

Figure 32-6 Right upper extremity

Wrist

The wrist is composed of eight small bones, the carpal bones, arranged in two rows of four. The carpal bones join with the distal ends of the radius and ulna to form the wrist joint. The wrist joint is capable of motion in four directions: extension, flexion, adduction, and abduction. The distal row of carpal bones articulates with the five metacarpal bones of the hand.

Hand

The 5 metacarpal bones and 14 phalanges — 3 for each finger and 2 for the thumb — make up the skeletal framework of the hand (see Figure 32-7 Right hand posterior). The metacarpal bone of the thumb has a special joint for flexion, extension, and rotation. The distal ends of the metacarpal bones articulate with the proximal row of finger bones — the phalanges.

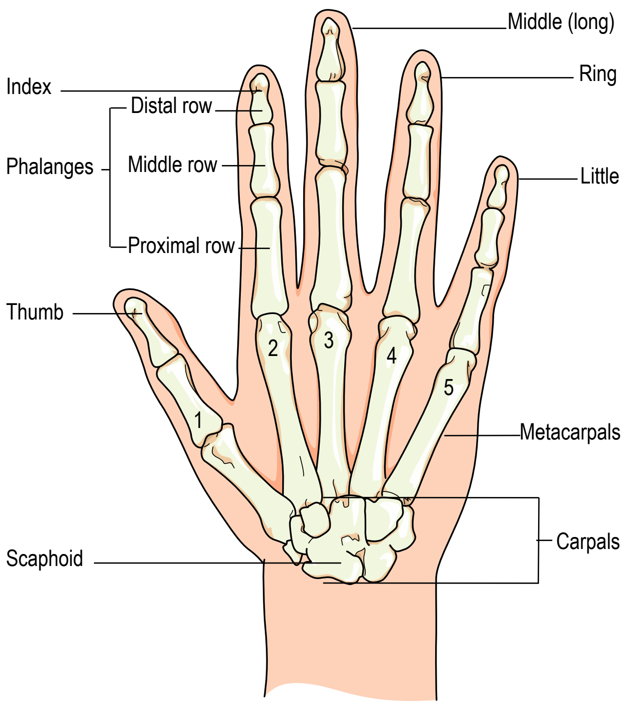

Figure 32-7 Right hand - posterior

Pelvis and lower extremities

On each side, the lower extremity includes the hip joint, thigh, knee joint, lower leg, ankle, and foot (see Figure 32-8 Right lower extremity).

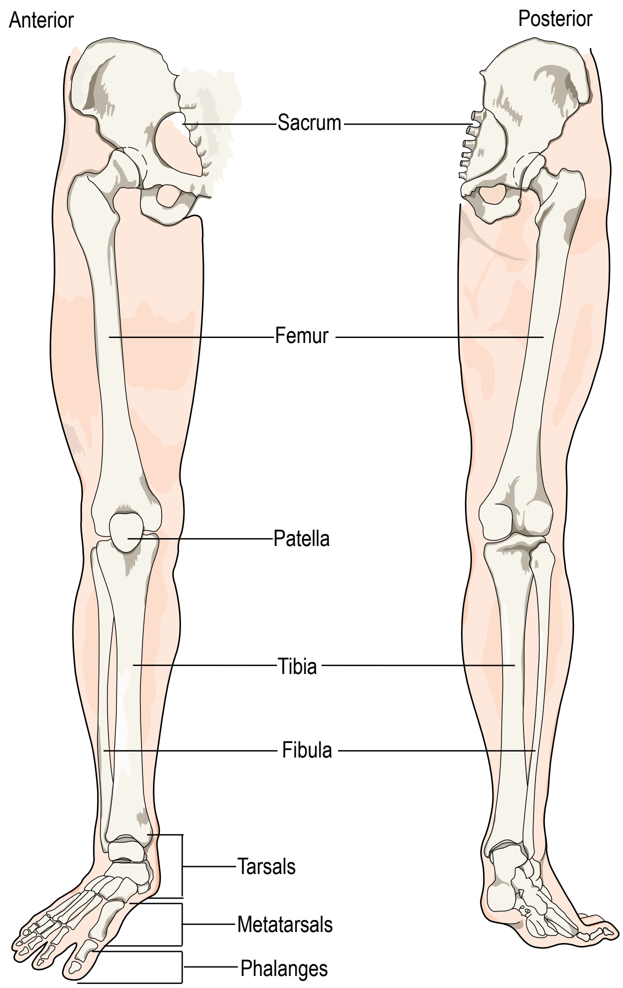

Figure 32-8 Right lower extremity

Pelvis

The pelvis forms the floor of the abdominal cavity. The pelvis is a bony ring made up of the sacrum and the two large, wing-like pelvic bones — innominate bones. Each innominate bone has three separate components: the ilium, ischium, and pubis. The pelvic bones join in front to form the symphysis pubis. Posteriorly, each pelvic bone articulates with the sacrum at the sacroiliac joint and is connected to it by broad, very strong ligaments.

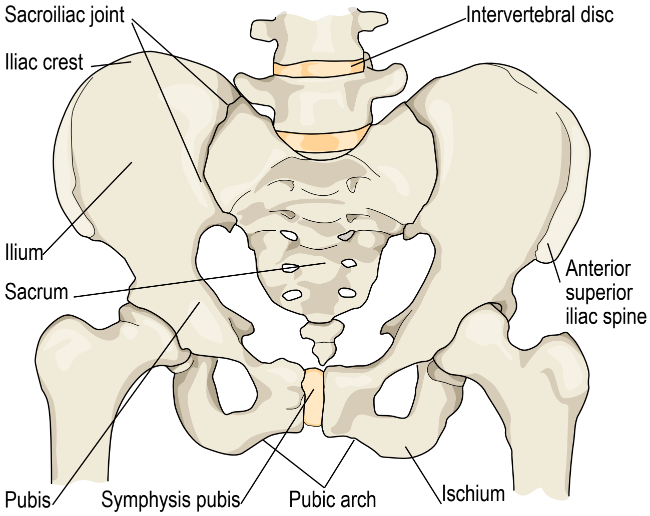

Figure 32-9 The pelvis - front view

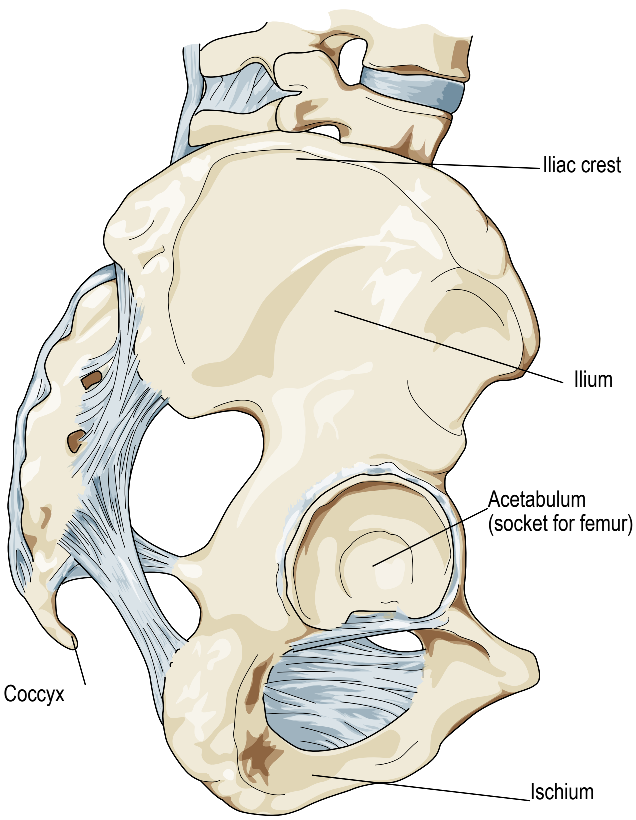

Figure 32-10 The pelvis - side view

The pelvic bones contain the sockets — acetabulum — for the hip joints (see Figure 32-9 The pelvis — front view and Figure 32-10 The pelvis —side view). The entire weight of the upper body is transmitted through the bony pelvic ring to the hip joint and down the legs.

The pelvis surrounds and provides protection for the contents of the pelvic cavity. In this cavity lies the bladder, the rectum, major blood vessels, and, in the female, the reproductive organs.

Thigh

The femur is the long bone of the thigh, extending from the hip to the knee. It is a strong, heavy bone, the longest in the body. At the proximal end of the femur is a rounded head that forms the ball of the ball-and-socket joint of the hip. Between the head and the shaft of the bone is a stout neck. At the base of the neck on the lateral side, where it joins the shaft, is a heavy mass of bone called the greater trochanter.

The distal end of the femur widens into two bony prominences, the lateral and medial condyles. The smooth articular surfaces of this end of the femur form a hinge joint with the tibia at the knee.

Knee

The knee joint is formed by the medial and lateral condyles of the femur, which articulate with the corresponding medial and lateral plateaus of the proximal end of the tibia. Its ligaments are very complex and quite susceptible to injury.

The patella, or knee cap, is a flat bone embedded in the tendon of the quadriceps muscle. It is about 5 cm (2 in.) long and 5 cm (2 in.) wide and has three bursae (pad-like sacs which allow skin to move over joints), one above, one in front, and one below. When the knee is bent, the patella becomes fixed against a notch in the condyles of the femur. The strong patellar ligament attaches the quadriceps muscle and patella to the anterior tibia.

Lower leg

The lower leg extends from the knee to the ankle and contains two bones, the tibia and fibula. The tibia, or shin bone, is the larger bone of the lower leg and is responsible for weight bearing. The upper (proximal) end of the tibia widens and flattens to form lateral and medial plateaus. The condyles of the distal femur roll on the tibial plateau when the knee is flexed or extended. The distal tibia is narrower and articulates with the talus at the ankle joint.

The fibula is a long, slender bone lateral to the tibia. Proximally, it articulates with the tibia inferior to the knee joint. Distally, it articulates with the talus and is joined to the tibia by a tough fibrous membrane.

Ankle and foot

The ankle joint is made up of the distal ends of the tibia and fibula articulating with the talus. At the ankle joint, the distal end of the tibia forms the medial malleolus. The distal end of the fibula forms the lateral malleolus. The two malleoli strengthen the ankle joint by completing the bony mortice and by giving attachment to the strong collateral ligaments.

The foot has seven tarsal bones. The talus fits into the mortice formed by the tibia and fibula to complete the ankle joint. The heel bone is called the calcaneus. The five metatarsals correspond to the metacarpals ofthe hand. There are two phalanges for the big toe and three for each of the other toes (see Figure 32-11 Right foot).

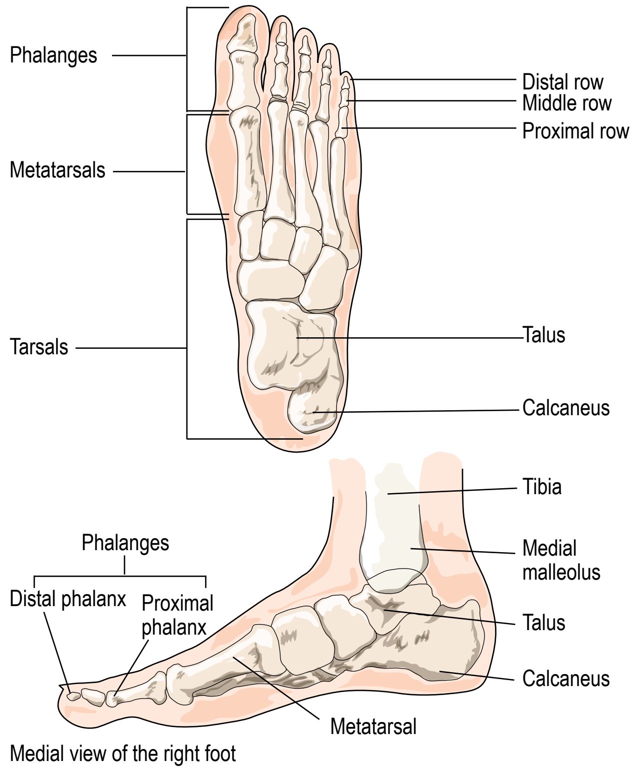

Figure 32-11 Right foot

32

Sprains, dislocations, and fractures

Recognition and management of sprains, dislocations and fractures is very important for the attendant. Proper management of a patient with a sprain, dislocation, or fracture will not only minimize pain but will also promote the patient's recovery. This chapter provides an overview of bone and joint injuries.

Mechanisms of injury

Sprains, dislocations, and fractures may be caused by:

- An angular force — e.g., a fall on an outstretched hand
- A direct blow
- A compression force — e.g., a fall from a height and landing on the feet
- A crush — e.g., a log landing on the pelvis

Sprains

A sprain is a stretching and/or a partial or complete tearing of a ligament at a joint (see Figure 33-1 Lateral ankle sprain). Sprains may vary in severity from partial tearing of a single ligament to complete disruption of multiple ligaments of a joint. If the attendant is not sure whether the injury is a sprain or fracture, they should always treat it as a fracture.

The signs and symptoms of sprains are similar at all movable joints:

- The history is usually one of a joint being twisted or stretched beyond its normal range of motion.
- Swelling can start immediately after injury and is always accompanied by pain.
- There is point tenderness at ligament attachments or along the length of the ligament.
- Pain is caused by movement in the direction that stretches the injured ligaments.

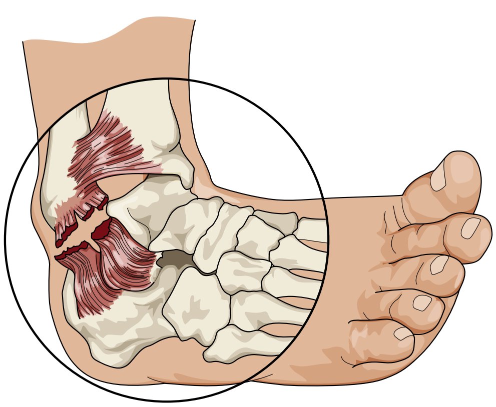

Figure 33-1 Lateral ankle sprain

Strains and/or sprains of the back or spine

Signs and symptoms of muscle strains and ligament sprains of the back

Mild muscle strains or ligament sprains can usually be differentiated from more serious injuries such as fractures. The best indicator is the mechanism of injury. Patients who report that they injured their back while lifting or twisting are likely to have a strain. Spinal fractures are unlikely in the absence of a force sufficient to cause a fracture — e.g., a fall down the stairs, a direct blow, a motor vehicle crash. Similarly, patients who cannot identify a specific injury that precipitated their back or neck pain, or who develop the pain hours after the injury (rather than immediately), are also likely to have a strain.

The major symptoms are pain and muscle spasm.

- The pain is usually limited to the site of injury and is worsened by movement.
- The pain may radiate away from the injury site — e.g., into the buttock.
- Muscle spasm limits the range of motion of the vertebral column.
- The muscle spasm may be severe enough to cause the patient to assume a stooped, angled, or rotated
- position and to be unable to straighten up without increasing the pain.

Management of Simple Spinal Sprains/Strains

Most patients with simple muscle strains or ligament sprains of the back or the spine may be managed by the attendant. These injuries are not medical emergencies and, in many cases, the patient may not require medical referral. The following lists describe the criteria for back strains or sprains that:

- Should be referred for medical attention
- May be managed at the workplace

Characteristics of injuries requiring referral for medical attention

- Mechanism of injury implies possible bony spinal injury:
  - Fall
  - Direct blow
  - Sudden deceleration injury, such as with a motor vehicle crash
- Pain, numbness, tingling, or weakness in an extremity distal to the injury
- Bowel or bladder symptoms — e.g., inability to urinate, incontinence of stool
- Persistent or worsening symptoms on follow-up
- The patient is non-ambulatory (unable to walk)
- Sudden onset of very severe pain

Characteristics of injuries that may be managed at the workplace

- Minor injury due to repetitive activity, awkward or static posture, twisting, bending, pushing, pulling, or lifting or a combination of these activities
- Gradual onset of symptoms
- The patient is ambulatory (able to walk) at the time of the examination
- No weakness, numbness, or tingling in the extremities

Workplace management

The evaluation and management of the worker with strains or sprains of the back follows the priority action approach to the Walk-In Patient outlined on page 193.

1. Ask the patient about any previous neck or back problems, and if there is any change from the usual pattern of pain. Use the mnemonic PQRST as a guide when questioning the patient about their pain.
2. Examine the area of injury thoroughly:
   a. Palpate the area and note any heat, redness, or other unusual signs.
   b. Have the patient move in all directions. This range of motion assessment is best conducted in a standing position. Ask the patient to extend both arms laterally when assessing rotation range of motion.
   c. Discover what movements cause pain, ask the patient to quantify the pain, on a scale of 1 to 10 and make a note of the findings in the first aid record.
3. Ice packs are usually helpful for most of these injuries. They should be applied for up to 20 minutes with a protective barrier, and may be continued intermittently if helpful. In the first few days after the injury, heat increases swelling of the injured area. The patient should avoid heat lamps, heating pads, and hot tubs.
4. The patient may take some over-the-counter analgesic or anti-inflammatory agents such as acetaminophen — e.g., Tylenol™ or ibuprofen — e.g., Advil™. See page 199, Non-Prescription Drugs and Medications.
5. Direct the patient to carry on their activities of daily living within the limitations of the pain as soon as possible. Complete rest weakens the muscles and extends recovery time. The attendant and patient should discuss altering the patient's work activity with the patient's supervisor.
6. Document the mechanism of injury and all findings, treatments, and recommendations in the first aid record (see page 199, Records and Reports).
7. Follow up the patient's injury in one to two days. Refer the patient to medical aid if the symptoms are persistent or worsen. Record all findings in the First Aid Record.

These injuries usually heal well without any complications, although the worker may be temporarily unable to do their regular job.

Dislocations

A dislocation is a displacement of one or more bones so that the joint surfaces are no longer in contact. When force is applied near a joint, one bone may become displaced from the other (see Figure 33-2 Elbow dislocation), instead of the bone breaking, as with fractures.

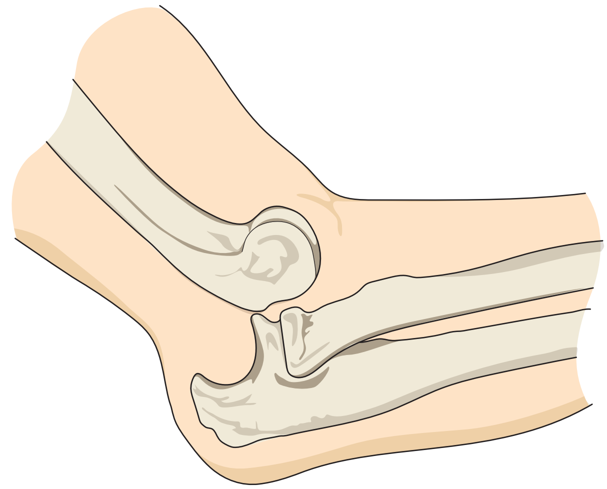

Figure 33-2 Elbow dislocation

A compound — open — dislocation is one in which the skin is broken, so air and bacteria can enter the injury site, just as with a compound or open fracture.

The usual signs and symptoms of a dislocation are essentially the same as of a fracture:

- Severe pain, especially around the ligaments
- Obvious gross deformity and irregularity
- A complete or near-complete inability to move the affected joint
- The joint is often locked in a deformed position

Fracture dislocations

A fracture dislocation is a dislocation associated with a fracture.

Fractures

A fracture is a break in the continuity of a bone (see Figure 33-3 Types of fractures).

Fractures are classified as:

- Closed (simple) fractures, where the surface of the skin is intact.
- Open (compound) fractures, where the surface of the skin is broken, usually by the bone.
- Contaminants have access to the fracture site. Therefore, foreign material and bacteria may enter and infect the bone and soft tissue.

Signs ands symptoms

For proper management, it is important to be able to recognize fractures. The signs and symptoms of fractures are:

- History — The mechanism of injury will tell the attendant what forces have been applied to the patient.
- Pain — The pain is generally sudden, may be extreme, and is usually localized to the site of the fracture.
- Deformity — The injured limb may be angulated or appear shorter than the uninjured one.
- Tenderness — Point tenderness at the fracture site is the most reliable indicator of a fracture.
- Swelling — The size of the part may increase. Swelling may occur with soft-tissue injuries, fractures, or dislocations. Swelling may be distal or inferior to the wound because of gravity.
- Loss of stability — The patient may be unable to use the extremity. The injured limb may not be able to support any weight.
- Discolouration (ecchymosis) — Black and blue marks may not be evident until some hours or days after the injury. As with swelling, discolouration can appear distal or inferior to the injury.
- Crepitus or a grating sound — There may be a grating sound or feeling when the ends of bones rub on each other. This sign should not be purposely brought about but may have occurred at the time of injury.

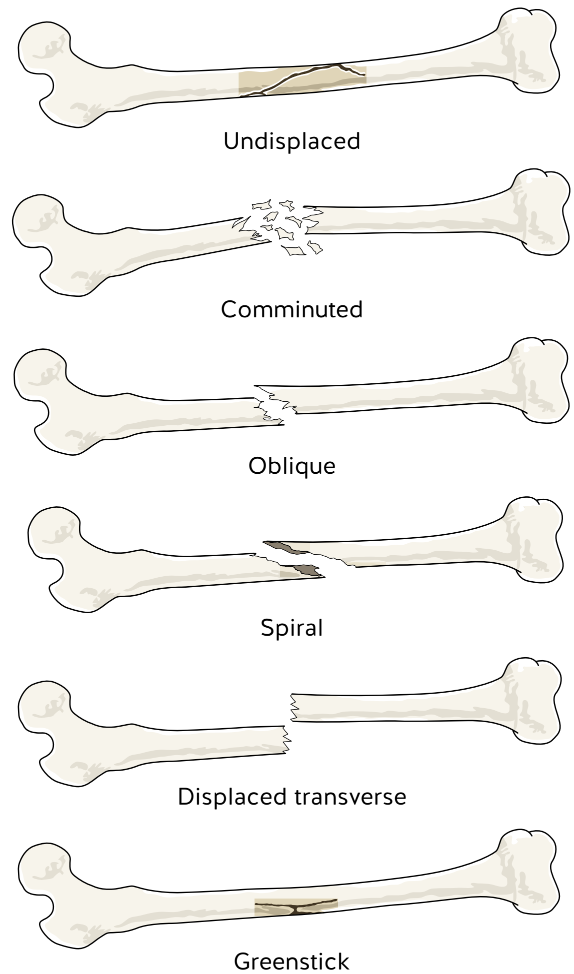

Figure 33-3 Types of fractures

Priority action approach to limb injuries

The evaluation and management of the worker with limb injuries follows the priority action approach outlined on page 18 or the priority action approach to the Walk-In Patient outlined on page 193.

1. Conduct the scene assessment.
2. Conduct a primary survey and perform critical interventions.
3. Conduct a secondary survey.
4. Always manage life-threatening conditions before attempting to manage any fractures or dislocations.

Principles of examination of limb injuries

Listen to the patient's story and to any bystanders who may have witnessed the accident. Knowing the mechanism of the injury can be of great value in making an accurate diagnosis. Ascertain whether the patient can move the injured limb. The main features of the history should be recorded.

Look for swelling, shortening, and angulation. Compare the injured limb with the uninjured limb. The patient usually can help identify the area injured.

Feel (palpate) gently for deformity, swelling, and point tenderness. Check for nerve damage by inquiring if feeling is present distal to the injury site and touching or asking the patient to move a distal part. Compare with the other limb. Numbness, tingling, and loss of movement may indicate nerve damage. Check circulation by looking at the colour and feeling the temperature of the distal part of the limb. Check the distal pulses and compare them with those of the other limb.

The finding of a weak or absent pulse distal to the injury site indicates either of the following conditions:

- Shock
- Vascular injury at the injury site

To differentiate the two conditions, the attendant must assess the pulses in the opposite limb. The finding of decreased or absent pulses in all limbs indicates shock. If the pulses are normal in the opposite limb, a vascular injury must be suspected. The finding of a cold, white, pulseless limb from a vascular injury is a limb-threatening emergency.

A patient with no circulation distal to a limb injury is considered to have a limb-threatening injury and is in the rapid transport category.

The attendant must fully examine the limb to determine if consultation with a physician is necessary (see page 248, Principles of Immobilization), quickly immobilize the limb, and transport the patient. The remainder of the secondary survey can be conducted en route.

If the patient is in shock or other RTC criteria exist, package the patient and transport as outlined on page 338, Patient Immobilization and Packaging for Rapid Transport.

Support the limb as much as possible during examination and treatment to reduce pain and avoid further injury. Look for any hidden injuries. Extreme pain from an injury may override or mask other injuries.

All the findings of the examination should be recorded. This is valuable information.

Immobilization

When there is a break in the continuity of tissue, the tissue loses its ability to support itself. The basic problem is the same whether the tissue broken is soft tissue or bone.

Soft-tissue damage is damage to skin, muscles, ligaments, tendons, blood vessels, or nerves. It may be more serious than damage to bone because healing may be prolonged or incomplete.

Immobilization refers to any method of holding a body part still and preventing movement. For example, a pressure bandage applied to a break in soft tissue tends to immobilize the injured tissue and helps stop bleeding by squeezing the injured blood vessels and keeping the tissue still.

If the patient is in the rapid transport category, only modified immobilization techniques for limb fractures should be used prior to transport — e.g., manual stabilization or anatomic splinting. The attendant may use more elaborate splinting techniques while waiting for the transport vehicle if all of the following apply:

- All life-threatening conditions have been managed.
- The patient is packaged and ready to be transported as soon as the transport vehicle arrives.
- The secondary survey has been completed and the patient is being regularly assessed.
- The urban attendant should dress and bandage open wounds associated with a fracture but it is not necessary to splint the limb if the patient is being transported by BCEHS resources. Manual stabilization is appropriate while waiting for the transport vehicle

Reasons for splinting

Joint movement near a soft-tissue injury will tend to move the tissue and cause further bleeding, so it may be necessary to immobilize nearby joints as well as the break in the soft tissue. Therefore, some soft-tissue wounds will require splinting as well as bandaging.

All fractures are complicated to some degree by damage to the soft tissue and structures surrounding the bone. A major cause of further tissue damage at a fracture site is movement of the broken bone ends. Normal elasticity of the muscles, as well as spasms of the muscles and their response to trauma, tends to pull the jagged bone ends into the surrounding tissue. The broken end of a bone is comparable to the broken end of a bottle in terms of the injuries it can cause to soft tissues. It is important, therefore, to prevent a fractured bone from rotating or further penetrating the soft tissues. The attendant's scope of practice includes splinting in specific circumstances; however, some commercially available splints will be beyond the attendant's scope of practice. In the absence of medical oversight and written permission from the employer's medical director, the attendant may be limited to applying rudimentary techniques and tools.

Types of splints

The most common splints are:

- Prepared wooden splints (see Figure 34-1a)
- Spine boards and scoop-style stretchers (see Figure 34-1b and 34-1c)
- Vacuum splint (see Figure 31-d)
- Malleable foam-covered splints (see Figure 34-1e)
- Anatomic splints

Prepared wooden splints

Wooden splints have been a staple lower limb splint for decades, and many remote or industrial workplaces will still have these as part of their first aid equipment. As mentioned earlier in this chapter, elaborate splinting of an RTC patient is not appropriate. This includes the urban attendant that will transport their patient using BCEHS resources. Wooden splints are inexpensive and may be improvised if necessary; however, they are no longer a preferred method for some applications (e.g., femur) and are inconsistent with present day continuum of emergency medical care. If wooden splints are the only lower-limb splinting tool available to the attendant that must transport their patient, they must be well-padded. They are used primarily to immobilize lower limb injuries.

Figure 34-1a Wooden splint

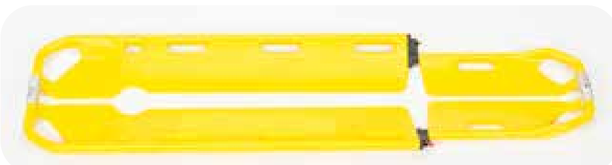

Figure 34-1b Scoop style stretchers

Figure 34-1c Spine board

Figure 34-1d Vacuum splint

Figure 34-1e Malleable foam-covered splint

Spine boards

Spine boards — also called fracture boards — are used primarily when full-body support is required for extraction from difficult environments (see Figure 34-1c). They are no longer recommended as a primary transportation device. When possible, patients should be removed from spine boards and placed on supportive padded surfaces for transport — e.g., firm padded mattress such as a stretcher, or a well-padded scoop stretcher on a soft mattress (see Figure 34-1b).

The spine board is approximately 2 cm by 45 cm by 1.8 m (¾ in. x 18 in. x 6 ft.), with straps and hand holds along the sides (see Figure 34-1c).

Malleable foam-covered splint — e.g., Sam® splints

Malleable splints are constructed from a thin core of pliable aluminum alloy, sandwiched between two layers of closed-cell foam (see Figure 34-1e). As it is constructed of a pliable metal, it can be bent into a shape that is suitable for splinting upper limbs and can be formed to create a suitable splint for lower third tibia/fibula or foot fractures. They are easier, faster and safer to apply than the expanded aluminum splints from the past. To give the pliable metal/foam splints strength, they need to be cambered and additional padding may be required to fill body hollows prior to securing with a bandage.

Anatomic splint

An anatomic splint uses the person's body as the splint. For example, taping a broken toe to the one next to it or securing an injured arm to the patient's chest or an injured leg to the uninjured leg.

Principles of immobilization

The evaluation and management of the worker with limb injuries follows the priority action approach outlined on page 18 or the priority action approach to the Walk-In Patient outlined on page 193.

- Steady and support the injured limb before and during the splinting.
- Open wounds, if any, should already have been covered with sterile dressings and bandaged appropriately. If the splint will not interfere with direct pressure, the splint-securing bandage may be used to secure the wound dressings.
- Cut away any clothing from above and below the injury site and remove any jewellery that may impede circulation.
- Check the circulation and motor and sensory functions distal to the injury site before and after splinting and every 30 minutes thereafter. Any impairment should be recorded and brought to the attention of the attending physician.

Apply cold if the circulation is not deficient. Cold must be applied as outlined on page 213, Application of Cold. Cold packs or ice packs should not be applied, either locally or distally, to fractured limbs when distal pulses are absent or circulation is impaired.

- Long bone and joint fractures of the upper and lower limbs are normally immobilized in the position found because altering the position of these injuries may damage blood vessels and/or nerves.
- A limb will need to be realigned if the limb is angulated to the point where the splint cannot be altered enough to immobilize the limb or the angulated limb will not fit inside the carrying device — basket stretcher (see Figure 34-2 Basket stretchers). If realignment is necessary, apply a gentle pull to the distal portion of the limb, then realign the limb and have a helper support in position.
  - Lower limbs are realigned to the anatomical position.
  - Upper limbs are realigned to a position along the body to facilitate immobilization using the body or splints.

Figure 34-2 Basket stretchers

- A patient with no circulation distal to a limb injury is considered to have a limb-threatening injury and is in the rapid transport category whether or not circulation has been restored.
- Select the proper length of splint to effectively immobilize the joints above and below the fracture. To determine the length of a splint, use the rule of thirds. Each long bone is divided into thirds. If the injury is located in the upper or lower third, assume that the nearest joint is unstable. The splints should extend to immobilize the joint above and below this unstable joint — e.g., for fractures of the upper third of the tibia, the management should include restricting movement of the hip because the knee is unstable.
- Pad the entire splint, paying particular attention to the natural body hollows and any deformities. Extra padding is often needed to make the limb comfortable. The padding will shape the splint to the limb and prevent pressure sores from developing.
- Avoid splinting over open wounds or gross deformities, if possible.
- Always anchor the splint to the stable proximal part of the body first, then to the part distal to the injury, and, finally, to the injured site. This avoids unnecessary movement of injured tissue or bones. Splint-securing material should be tight enough to

support the limb and prevent movement but not so tight that it interferes with circulation or causes increased pain.
- If direct pressure is maintained over a wound by a loop-tie bandage, do not release the pressure of the loop-tie bandage when securing the splint. Do not trap a tied or wrapped bandage under splints. It may cause a dangerous constriction and interfere with access to wounds. The exceptions to this rule are:
  - Loop-tie bandages with the knot exposed/accessible
  - Fracture straps with the Velcro ends exposed/accessible
  - Tourniquets applied to stop severe bleeding
- Elevate the injured limb, if possible, after immobilization. This will often provide comfort for the patient. If elevated, the limb should be raised approximately 30 cm (12 in.) and supported throughout its length with blankets and sandbags. If there is impaired circulation distal to the injury in the affected limb, the limb should be managed in the horizontal position.

Generally, fractures and dislocations in non-RTC patients, should be immobilized before the patient is moved. Circumstances may require that the patient be moved with helpers stabilizing the fractured limb. Providing there are no indications for rapid transport, all fractures and dislocations should be immobilized before the patient is transported.

Manual traction and limb manipulation

- When the limb is cold and pulseless with obvious angulation, it may be necessary to manipulate the limb in an attempt to restore some circulation. This is attempted under direct instructions from a physician. Contact a physician for instructions if both of the following conditions exist:
  - The limb is cold and pulseless with a joint injury or obvious angulation and
  - There will be more than one hour between the time of the injury and the patient's arrival at the hospital

Management of upper limb injuries

Upper limb splinting is a type of first aid treatment where the movement of an arm, shoulder, elbow, wrist, or hand is supported or restricted by a piece of material. The general principles of immobilization should be followed when treating patients who have upper limb injuries.

Using pliable metallic foam splints

This type of splinting material is made of a strip of lightweight aluminium with a closed-cell foam bonded to it on both sides. This type of splint is soft and adaptable and is suitable for splinting upper limbs. They are usually rolled up or folded into a compact unit and may be included in a first aid kit (see Figure 35-1 Malleable foam splint).

Unless it causes considerable pain, an injured hand should be placed and maintained in the position of function with extension of the wrist, the hand relaxed, and the fingers slightly flexed (see Figure 35-2 Finger fracture — hand in position of function). Maintain this position with a pad in the palm of the hand or a suitably formed splint. If the fingers are markedly displaced, splint them in the position found.

Figure 35-1 Malleable foam splint

Crepe bandages are recommended to secure the pliable metallic/foam-covered splint to the upper limb. Securing a splint should begin at the proximal stable part of the limb. Consequently, the crepe bandage should be applied from the proximal to the distal part of the limb — secure from stable to unstable.

Assess circulation. For upper limb injuries, the radial pulse is the most reliable indicator of circulation. The tips of the fingers should be accessible unless they are injured. Circulation in the injured limb must be compared with the uninjured limb. The ulnar artery also provides blood supply to the hand but it is usually not palpable. If the radial pulse cannot be palpated but the fingers are warm and not pale, adequate circulation is being provided by the ulnar artery. Assess circulation before and after splinting and every 30 minutes thereafter. Any impairment should be recorded to bring it to the attention of the attending physician.

Figure 35-2 Finger fracture — hand in position of function

Assess neurological function. With upper limb injuries, the attendant should assess the motor and sensory functions in the hand before and after splinting and every 30 minutes thereafter. Any impairment should be recorded to bring it to the attention of the attending physician.

Slings

Slings are used to help immobilize upper limb injuries. They are normally used with splints but sometimes slings, padding, and wide transverse bandages are all that is necessary for complete immobilization.

Some injuries requiring only sling, padding, and transverse tie immobilization are:

- Scapula fractures
- Clavicle fractures
- Shoulder dislocations
- Mid-third humerus fractures

Four types of slings can be used:

- The large arm sling is used when full arm support is required (see Figure 35-3).
- The small arm sling is used to support the wrist and hand, leaving the elbow free.
- The triangular arm sling holds the forearm, with the elbow in acute flexion (see Figure 35-4).
- The collar and cuff sling is used for the same purpose as a small arm sling. It will not slip off the patient's arm and is useful when the angle of the elbow is more than 90 degrees.

Figure 35-3 Large arm sling

Figure 35-4 Triangular arm sling

Scapula fractures

Cause

Scapula fractures are most often caused by a substantial force applied directly over the scapula.

Signs and symptoms

In addition to the general signs of a fracture, indications of a scapula fracture may include:

- Tenderness over the immediate area of the scapula
- A limited range of shoulder motion
- Local swelling

Possible complications

The scapula is embedded in muscle and is a substantial bony structure. An injury that would fracture the scapula may also cause rib fractures and internal chest injuries.

Management

- If the patient is ambulatory, support the limb in the position found and assist the patient into an appropriate position as outlined on page 24, Positioning the Patient for the Primary Survey and on page 193, The Priority Action Approach to the Walk-In
- Examine the limb as outlined on page 245, Principles of Examination of Limb Injuries
  - Immobilize the limb as outlined on page 248, Principles of Immobilization.
  - Place the affected arm in a an appropriate sling (see Figures 35-3 Large arm sling and 35-4 Figure 35-4 Triangular arm sling) and then, to maintain the position of the arm, place supportive padding between the patient's trunk and arm as needed.

- Apply one or more transverse wide bandages around the affected arm, and then secure the arm with the padding against the patient's trunk. The objective is to limit the movement of the arm on the affected side (see Figure 35-5 Triangular sling with a wide transverse bandage), while maintaining the arm in the position of most comfort.
- If the patient is lying down, provide support to the affected arm to make the patient more comfortable.

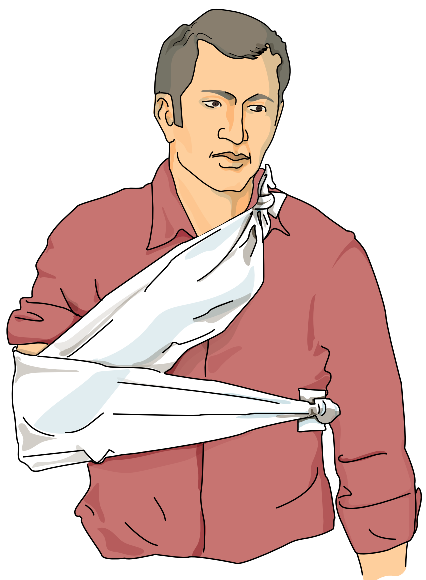

Figure 35-5 Triangular sling with a broad transverse bandage

Clavicle fractures

Causes

Clavicle fractures are most often caused by:

- A direct blow to the clavicle or shoulder
- A fall on the outstretched arm

Signs and Symptoms

In addition to the general signs of a fracture, indications of a clavicle fracture may include:

- Irregularity of the clavicle
- The patient may hold the arm against the chest with the other hand
- The patient may be reluctant to move the arm on the affected side because of pain

Possible complications

Complications of clavicular fractures are rare, although if the injury is severe enough, other chest wall structures (ribs) the lungs, or major vessels and nerves may be damaged.

Management

If the patient is ambulatory:

- Support the limb in the position found and assist the patient into an appropriate position as outlined on page 24, Positioning the Patient for the Primary Survey or page 193, The Priority Action Approach to the Walk-In Patient.
- Examine the limb as outlined on page 245, Principles of Examination of Limb Injuries.
- Immobilize the limb as outlined on page 248, Principles of Immobilization:
  - Apply a triangular arm sling to keep the weight off the injured clavicle. The sling should be tightened from the back to draw the shoulder slightly upward and backward.
  - Apply appropriate padding and a transverse wide
  - bandage to limit the movement of the arm on the affected side.
  - If the patient is lying down, provide support to the affected arm to make the patient more comfortable.

Bilateral clavicle fractures

If both clavicles have been fractured, using slings could irritate the fractures and should be avoided. The amount of force applied to the chest area that is required to fracture both clavicles may have caused more serious underlying damage to the chest or its contents. In the absence of chest or other system injuries, the best treatment for bilateral fractured clavicles is to lay the patient supine on a stretcher with a firm pad or rolled blanket between the shoulder blades. This will pull the shoulders back and provide some traction for the injured clavicles.

Shoulder dislocations

Causes

Several mechanisms can cause a shoulder dislocation:

- The patient may have fallen on the point of the shoulder.
- The arm may have been forcefully externally rotated and/or abducted.
- The patient may have a history of recurrent shoulder dislocations. They may reoccur with minimal trauma or abduction movements.

Signs and symptoms

Indications of a shoulder dislocation may include:

- The patient may hold the dislocated arm with the other hand to stabilize it.
- Pain, sometimes extreme.
- Deformity.
- Dislocations are most often anterior but they may be posterior or inferior. In an anterior dislocation, the humeral head comes out of the shoulder joint and lies anterior and below the shoulder joint. This means that the roundness of the shoulder is lost and there is usually a hollow below the point of the shoulder.
- The arm may be fixed in a position away from the trunk.

Possible complications

Complications of shoulder dislocations may include:

- Circulation impairment
- Nerve injury
- Fracture of the humerus

Management

- Support the limb in the position found and assist the patient into an appropriate position as outlined on page 24, Positioning the Patient for the Primary Survey or page 193, The Priority Action Approach to the Walk-In Patient.
- Support the injured area with a blanket or pillow.
- The patient will often immobilize the dislocated arm by holding the wrist with the other hand.
- Examine the limb as outlined on page 245, Principles of Examination of Limb Injuries.
- Immobilize the limb as outlined on page 248, Principles of Immobilization.
- Place padding between the arm and chest and secure the arm against the body without making it hard for the patient to breathe.
- If the patient is sitting or semi-sitting, a large arm sling can be used, secured with a wide transverse bandage.
- Do not attempt to reduce (relocate) a dislocated shoulder if there is distal circulation because of the danger of damaging a nerve or blood vessel.
- If transportation is delayed more than two hours and this is a recurrent shoulder dislocation after minimal trauma (e.g., after abduction of the arm) a reduction may be considered. A physician must be contacted to obtain specific instructions for reducing the dislocation.

  The simplest effective method is as follows:

  1. Place the patient face down on a high bed or bench with the affected arm dangling over the side and the bed supporting the upper lateral chest.
  2. Fix a weight of approximately 2 kg to 4 kg (4.5 lb. to 9 lb.) to the dangling wrist.
  3. Keep the patient in this position for up to 45 minutes or until the dislocation is reduced.
  4. The patient must still be assessed by a physician even after a successful reduction.

Upper arm fractures (upper-third humerus)

Fractures of the upper humerus may have signs, symptoms, and complications similar to those with dislocations of the shoulder joint.

Because of the similarity between these two injuries, they are very difficult to differentiate without an X-ray. For details of management, follow the management for shoulder dislocations.

Upper arm fractures (middle-third humerus)

Causes

Upper arm fractures are most often caused by:

- A twist or fall on the outstretched arm
- A direct blow

Signs and Symptoms

In addition to the general signs of a fracture, indications of an upper arm fracture may include:

- An inability to flex or extend the wrist and fingers
- "Wrist drop," caused by damage of the radial nerve, with an inability to extend the wrist (see Figure 35-6)
- Shortening of the upper arm

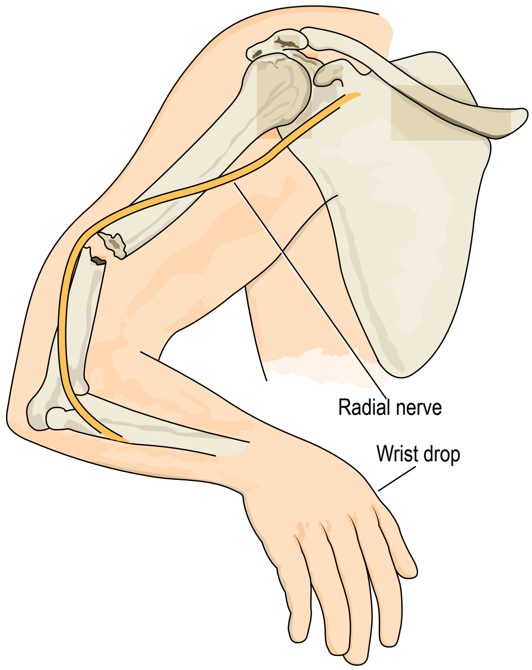

Figure 35-6 Wrist drop caused by radial nerve damage

Possible complications

Complications of upper arm fractures may include:

- Swelling which may impede circulation
- Radial nerve damage as demonstrated by inability to extend the wrist
- Blood vessel damage

Management

- Support the limb in the position found and assist the patient into an appropriate position as outlined on page 23, Positioning the Patient for the Primary Survey or page 193, The Priority Action Approach to the Walk-In Patient.
- Examine the limb as outlined on page 245,
- Principles of Examination of Limb Injuries.
- Immobilize the limb as outlined on page 248, Principles of Immobilization.
- Secure a splint to the arm with a crepe bandage.
- If a full arm splint is not practicable, support for the arm may be achieved using a pillow or folded blanket with additional padding placed between
  - the arm and chest as needed. The arm and padding is then secured against the patient's trunk. The objective is to limit the movement of the arm on the affected side while maintaining the arm in the position found or the position of most comfort.
- Support the immobilized limb, either in the appropriate sling if the patient is ambulatory (see Figure 35-7 Padding and large arm sling), or fully supported at the side if the patient is lying down.

Elbow fractures or dislocations (lower-third humerus, elbow, upper-third radius/ulna)

Causes

Elbow fractures and dislocations are most often caused by a:

- Fall on the extended arm
- Fall on the flexed elbow
- Fall on the outstretched hand
- Force applied at the elbow
- Direct blow

Figure 35-7 Padding and large arm sling

Signs and symptoms

In addition to the general signs of a fracture, indications of an elbow fracture may include:

- instability of the elbow joint
- decreased circulation
- weakness of the muscles of the hand due to nerve involvement

Possible complications

This is often a very serious fracture due to the possibility of major blood vessel damage and nerve involvement (see Figure 35-8 Possible complications of elbow fractures).

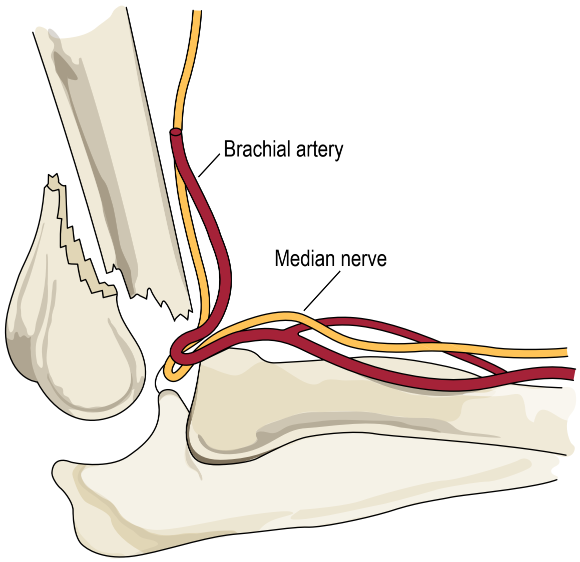

Figure 35-8 Possible complications of elbow fractures

Management

- Support the limb in the position found and assist the patient into an appropriate position as outlined on page 24, Positioning the Patient for the Primary Survey or page 193, The Priority Action Approach to the Walk-In Patient.
- Examine the limb as outlined on page 245, Principles of Examination of Limb Injuries.
- Immobilize the limb as outlined on page 248, Principles of Immobilization.
- Support for the arm may be achieved using a pillow or folded blanket with additional padding similar to the management of a mid-third humerus fracture.
- Support the immobilized limb, either in the appropriate sling if the patient is ambulatory, or fully supported at the side if the patient is lying down.

Forearm fractures (middle-third radius/ulna)

Causes

Forearm fractures are most often caused by:

- A direct blow
- A fall on an outstretched hand

Signs and Symptoms

- In addition to the general signs of a fracture (see Figure 35-9 Compound forearm fracture), indications of a forearm fracture may include:
- Shortening of the injured arm
- Limited range of wrist or finger movement
- Limited range of forearm movement

Figure 35-9 Compound forearm fracture

Possible complications

Complications of forearm fractures may include:

- Circulation impairment
- Nerve involvement

Management

- Support the limb in the position found and assist the patient into an appropriate position as outlined on page 24, Positioning the Patient for the Primary Survey or page 193, The Priority Action Approach to the Walk-In Patient.
- Examine the limb as outlined on page 245, Principles of Examination of Limb Injuries.
- Immobilize the limb as outlined on page 248, Principles of Immobilization.
- Apply a formed and well-padded splint.
- Secure a splint to the arm with a crepe bandage snug enough to maintain support. Support for the arm may also be achieved using a pillow or folded blanket with additional padding similar to the management of a lower third-humerus fracture.
- Support the immobilized limb, either in the appropriate sling if the patient is ambulatory, or fully supported at the side if the patient is lying down.

Wrist fractures and dislocations (lower-third radius/ulna)

Causes

Wrist fractures and dislocations are most often caused by:

- A fall on an extended arm and open hand
- A direct blow
- A twisting injury

Signs and symptoms

In addition to the general signs of a fracture (see Figure 35-9 Compound forearm fracture), indications of a wrist fracture or dislocation may include:

- An inability to flex or extend the wrist
- An inability to use the hand
- A deformity in the shape of a dinner fork called a Colles' fracture — this is the most common injury in this area

Possible complications

Complications of wrist fractures or dislocations may include:

- Blood vessel damage
- Nerve involvement
- Tendon damage

Management

- Support the limb in the position found and assist the patient into an appropriate position as outlined on page 24, Positioning the Patient for the Primary Survey or page 193, The Priority Action Approach to the Walk-In Patient.
- Examine the limb as outlined on page 245, Principles of Examination of Limb Injuries.
- Immobilize the limb as outlined on page 248, Principles of Immobilization.
- Apply a formed, well-padded pliable metal/foam elbow splint measuring from the axilla to past the fingertips.
- Secure the splint to the arm snugly enough to give support. Support for the arm may also be achieved using a pillow or folded blanket with additional padding similar to the management of a mid-third radius/ulna fracture.
- Support the immobilized limb, either in the appropriate sling if the patient is ambulatory, or fully supported at the side if the patient is lying down

Hand and finger fractures and dislocations

Causes

Hand and finger fractures and dislocations are most often caused by:

- A direct blow
- A fall
- A twisting injury

Signs and symptoms

Indications of hand and finger fractures and dislocations are the same as the general signs of a fracture (see Figures 35-2 Finger fracture — hand in position of function and 35-9 Compound forearm fracture).

Possible complications

Complications of hand and finger fractures and dislocations may include:

- Blood vessel damage
- Nerve involvement
- Tendon damage

Management

- Support the limb in the position found and assist the patient into an appropriate position as outlined on page 24, Positioning the Patient for the Primary Survey or page 193, The Priority Action Approach to the Walk-In Patient.
- Examine the limb as outlined on page 245, Principles of Examination of Limb Injuries.
- Immobilize the limb as outlined on page 248, Principles of Immobilization.
- Apply a formed, well-padded pliable metal/foam splint measuring from the elbow to past the fingertips.
- Unless it causes considerable pain, place the hand and fingers in the position of function, with extra padding in the palm.
- Secure the splint to the arm snugly enough to give support. Support for the hand and fingers may also be achieved using a pillow or folded blanket secured to the hand, wrist and forearm, using triangular bandages or fracture straps.
- Support the immobilized limb, either in the appropriate sling if the patient is ambulatory, or fully supported at the side if the patient is lying down.

Management of lower limb injuries

The legs consist of some of the largest and strongest bones in the human body. The legs also contain some of the body's larger blood vessels, muscles, and other connective tissues. Workplace accidents can damage the legs causing sprains and strains, joint dislocations, and fractures. The evaluation and management of the worker with lower limb injuries follows the priority action approach outlined on page 24 (positioning the patient for the primary survey) or the priority action approach to the Walk-In Patient outlined on page 193.

Principles of immobilization

The general principles of immobilization (see page 248, Principles of Immobilization) should be followed when treating lower limb injuries

Additional specific lower limb immobilization principles

- If the splint does not come with an engineered means of securing it to the injured limb (see Figure 36-1 Engineered splints) to avoid unnecessary movement of the limb, always place splint-securing ties before placing the splints.
- Use wide elastic straps with Velcro attachments or triangular-fold bandages wherever possible (see Figure 36-2 Elastic strap bandage).
- Always attempt to use rigid splints to immobilize the limb. If using rigid splints is not practicable, the attendant may place a folded blanket between the legs and secure the legs together using wide elastic straps with Velcro attachments or triangular bandages.
- The Velcro attachments of the wide elastic splint-securing straps should be accessible to the attendant once applied. Triangular bandage knots, if used, should always be padded so they do not press on the patient's skin. Empty the patient's pockets of objects that may cause pressure sores.
- Pliable metal/foam splints used for added ankle and foot support should conform to the natural shape of the foot and be well padded.
- Alternatives to rigid materials for the foot and ankle include folded blankets, or a pillow wrapped around the foot and ankle and secured with elastic straps or triangular bandages.
- Use splint-securing ties/straps to ensure adequate support of the limb. Table 36-1 lists the tying/strapping order for splinting.

Figure 36-1 Engineered splints

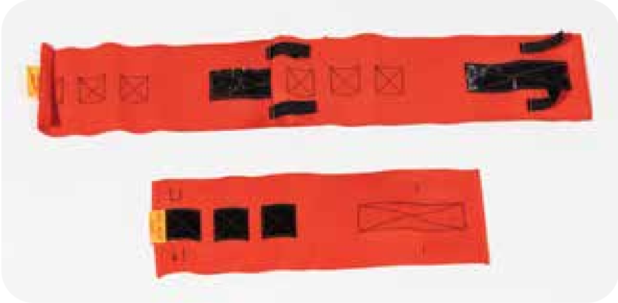

Figure 36-2 Elastic strap bandage

Order for tying splint-securing ties
1. Upper thigh
2. Ankle — figure of 8
3. Above the injury site
4. Below the injury site
5. Knee

Table 36-1

Pelvic fractures

Causes

Fractures of the pelvis are most often caused by direct compression. Such injuries may occur in a fall from a height, crushing, or violent impact to the pelvic area. Indirect force, such as the force transmitted along the femur when the knee strikes the dashboard in a head-on motor vehicle crash (see Figure 36-3 Knee impact can cause proximal injuries), can also cause pelvic fractures. Suspect pelvic fractures in any high-velocity injury. Patients suspected of having a fractured pelvis require urgent medical aid.

Signs and symptoms

In addition to the general signs of a fracture, indications of a pelvic fracture may include:

- Pain in the groin on the affected side
- Increased pain in the pelvic region upon gentle compression of the iliac crest or pressure over the pubic symphysis
- Inability to move the lower limbs
- Shock

Open (compound) fractures of the pelvis are rare because of large adjacent muscles.

Possible complications

- Internal hemorrhage may often cause hypovolemic shock as large blood vessels lie adjacent to the pelvis and may easily be lacerated. The extent of bleeding is often not obvious because bleeding occurs within the pelvic cavity.
- There may be tearing or rupture of the bladder or urethra (with possible blood at the urethral opening).
- The femur may be fractured or dislocated.

Management

- Suspected pelvic fractures are in the rapid transport category. Immobilize as outlined on page 338, Patient Immobilization and Packaging for Rapid Transport.
- It is preferable that the patient not void — urinate. Ifthere is a urethral tear, voiding may allow urine to leak into adjacent tissues.
- Place adequate padding between the legs and support them by securing the ankles, knees, and thighs together. When securing the ankles, do not use a figure 8 tie around the feet, as this will force the legs to rotate and cause pain.

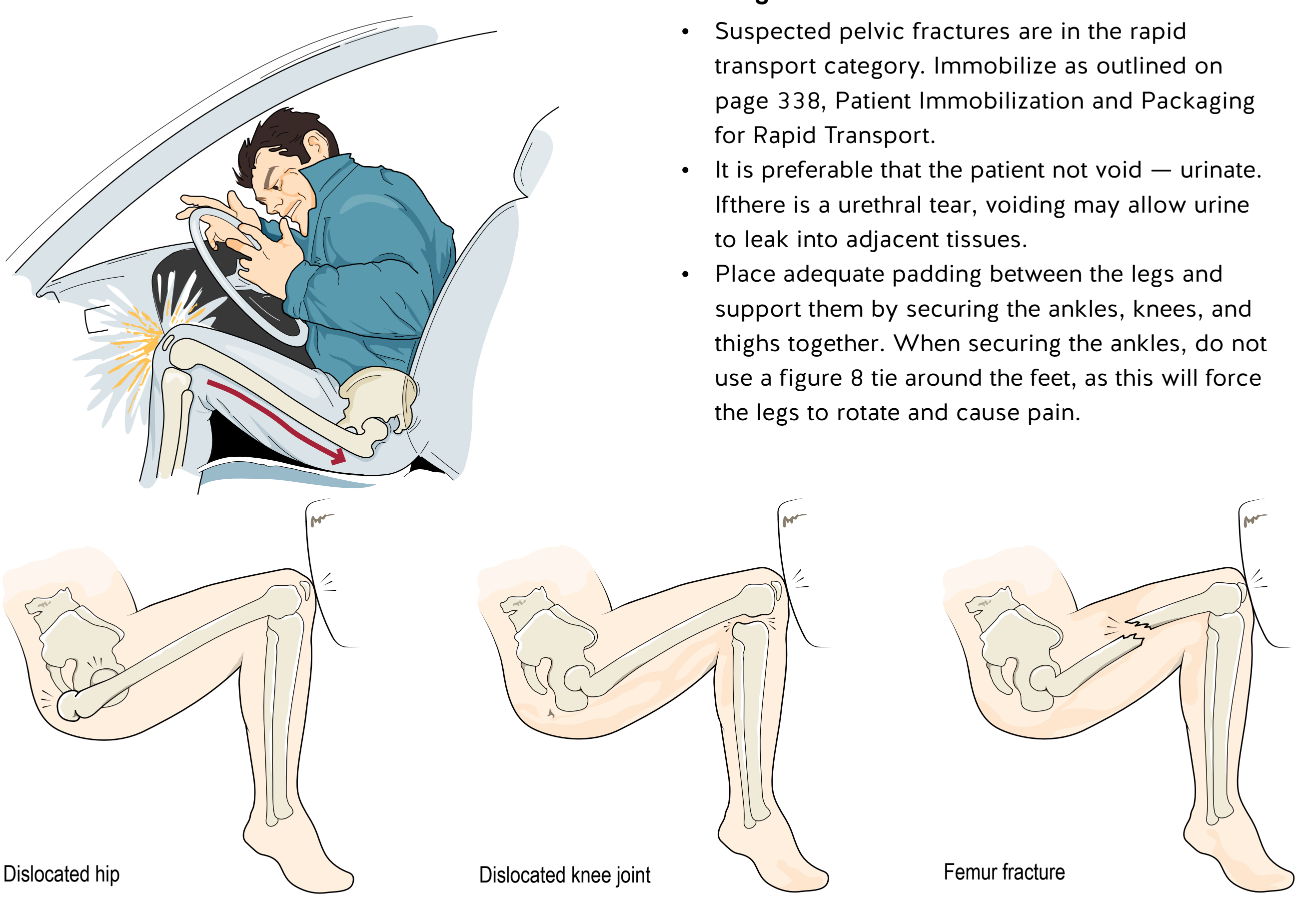

Figure 36-3 Knee impact can cause proximal injuries

- Support the pelvic area if pelvis fracture is suspected. There are a few ways to do this but whatever method is used, the attendant must do this quickly. The attendant may apply:
  - Three overlapping broad triangular bandages around the pelvis
  - A thin sheet wrapped around the pelvis secured with a stable knot or a tool that can hold the sheet snug
  - Firm, wide elastic straps with Velcro attachments
  - A commercially available pelvic binder strap
- Whatever method the attendant chooses, the top of the wrap should be just inferior to the iliac crests. Secure the device tightly enough to support the pelvis but not cause pain.
- If pelvic binder materials are not practicable in the circumstances or are unavailable, the objective may be met by using a clamshell or scoop-style stretcher with rolled blankets on either side of the pelvis. The stretcher securing ties can be used to provide side support of the pelvis once on the stretcher. The patient can then be safely moved into a well-padded stretcher or ambulance cot. A spine board may be needed for extraction. Once extracted, the patient should be moved onto a well-padded stretcher for transport (see Patient Packaging chapter 48).
- Support body curves with appropriate padding.
- A blanket or pillow may be placed under the patient's knees to maintain flexion. This will usually make the patient more comfortable. It should not be done if it causes pain or the patient has a suspected lower extremity fracture.
- Once a pelvic fracture is suspected, the attendant must monitor the patient's general condition and vital signs closely and watch for signs of hypovolemic shock.

Hip fractures and dislocations (upper-third femur)

A fracture of the upper third of the femur is called a hip fracture. The damage may occur in the head or neck of the femur. Dislocations and fractures of the hip have similar consequences. The first aid treatment is the same for both injuries and is covered in this section.

Causes

Hip fractures and dislocations may be caused by:

- Any strong impact that forces the femur into the pelvis — e.g., when a flexed knee strikes a dashboard
- A twisting force exerted on the femur, which may occur in a fall
- A direct blow

Signs and symptoms

In addition to the general signs of a fracture, indications of a hip fracture or dislocation may include:

- Pain, usually severe, at the site of injury
- An inability to move the affected leg
- Shortening and external rotation of the affected limb for a fracture
- For a dislocation, deformity of the hip, anterior or posterior

Posterior dislocations

- The leg may be turned inward with the knee and hip flexed and the knee lying against the opposite leg (see Figure 36-4 Posterior hip dislocation).
- There may be a hard lump in the buttock of the affected side.
- The affected leg may be shortened.
- The patient may not be able to raise their toes or foot (foot drop) because of damage to the sciatic nerve.
- Distal pulses in the affected limb may be absent.

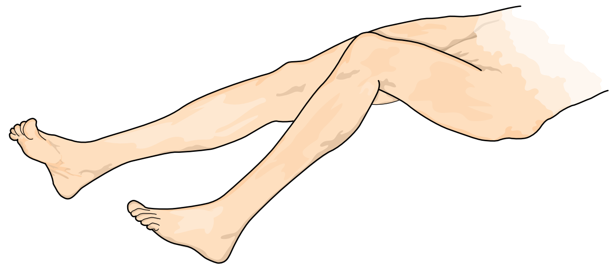

Figure 36-4 Posterior hip dislocation

Anterior dislocations

- The limb may be rotated outward and abducted.
- The affected leg may be longer.

Anterior dislocations rarely occur.

Possible complications

Complications of hip fractures and dislocations may include:

- Nerve and vessel damage to the affected
- lower extremity
- Fracture of the joint socket
- Fracture of the pelvis
- Injury to the knee

Management

A patient with a hip dislocation/fracture is considered to have a limb-threatening injury and is in the rapid transport category.

- Quickly support the injured limb using helpers, rolled blankets, or pillows and ties.
- Move the patient onto a firm, blanketed/padded basket stretcher. Secure the patient to the basket stretcher to eliminate motion in the affected hip. Early medical reduction of this dislocation is essential to avoid serious long-term complications.
- Conduct any remainder of the secondary survey en route to medical aid. Maintain a regular check of the vital signs, the patient's general condition, and the state of distal pulses and neurological function in the affected limb. If a dislocation is suspected and if the hip spontaneously reduces during treatment or transportation, notify the attending physician.

Femur fractures

Cause

Femur fractures are usually caused by trauma involving stress or violent impact to the thigh.

Signs and symptoms

In addition to the general signs of a fracture, indications of a femur fracture may include:

- Severe pain
- Possible deformity
- The foot of the injured limb lying on its outer side due to rotation of the entire limb distal to the fracture site
- A shortened injured limb
- The range of movement being limited by pain
- Swelling at the injury site whether the fracture is closed or open

Possible complications

- The blood vessels may be damaged and a patient may lose one or two litres of blood into the thigh. There may be external hemorrhage if the fracture is open. Patients with such fractures may develop hypovolemic shock. Therefore, monitor for signs of shock (see page 96, Shock).
- There may be circulatory or nerve impairment to the distal limb, particularly with lower-third femoral fractures.
- Muscles in the thigh are powerful and, when stability of the femur is lost, these muscles contract, causing the bone ends to override each other.
- There may be foreign bodies (e.g., dirt or clothing) in the wound or bacterial contamination if the fracture is compound (open).

Management

- Support the limb in the position found and assist the patient into an appropriate position as outlined on page 24, Positioning the Patient for the Primary Survey.
- Examine the limb as outlined on page 245, Principles of Examination of Limb Injuries.
- Immobilize the limb as outlined on page 248, Principles of Immobilization.
- Apply appropriate-length padded splints or improvised splints and if possible, avoid placing them over wounds, swelling, or obvious deformity. The joints above and below the site of the fracture must be immobilized.

Knee dislocations

Knee dislocations are very serious injuries.

Cause

Knee dislocations are caused by a force strong enough to tear ligaments and displace bone ends.

Signs and symptoms

IIndications of a knee dislocation may include:

- Pain, usually severe.
- Marked deformity and swelling. The proximal end of the tibia is completely displaced from its articulation with the femur.
- Loss of stability, and often an inability to move the joint.

Possible complications

Complications of knee dislocations may include:

- Damage to or compression of the popliteal artery, causing a loss of distal circulation — the most serious complication of this injury
- Nerve damage, as evidenced by paralysis and/or numbness of the foot
- Ligament tears and joint capsule damage

Management

A patient with a dislocated knee is considered to have a limb-threatening injury and is in the rapid transport category.

- Support the limb in the position found, conduct the primary survey and assist the patient into an appropriate position as outlined on page 24, Positioning the Patient for the Primary Survey.
- Examine the limb to determine if a physician must be consulted because of absent circulation as outlined on page 245, Principles of Immobilization.
- Quickly support the injured limb using helpers, blankets, and ties. Dislocation may result in a number of different limb and joint positions.
- Move the patient onto a firm, padded/blanketed
- basket stretcher. Secure the patient to the stretcher to eliminate motion in the affected leg.
- Conduct any remainder of the secondary survey en route to medical aid. Maintain a regular check of the vital signs, the patient's general condition, and the state of distal pulses and neurological function in the affected limb. If the dislocation spontaneously reduces during treatment or transportation, notify the attending physician.

Knee fractures (lower-third femur, knee, upper-third tibia/fibula)

Cause

Knee fractures are generally caused by trauma involving stress or violent impact to the leg.

Signs and symptoms

In addition to the general signs of a fracture, indications of a knee fracture may include:

- Severe pain.
- An inability or reluctance to flex the knee or move the limb.
- Broken fragments of the patella may be felt. They may be widely separated.

Possible complications

Complications of knee fractures may include:

- Intra-articular fractures of the femur or tibia
- Nerve and blood vessel injury

Management

- Support the limb in the position found, conduct the primary survey and assist the patient into an appropriate position as outlined on page 24, Positioning the Patient for the Primary Survey.
- Maintain any flexion of the knee with padding placed behind the knee.
- Examine the limb as outlined on page 245, Principles of Examination of Limb Injuries.
- Immobilize the limb as outlined on page 248, Principles of Immobilization.
- Splint the limb in the position found.

Traumatic dislocation of the patella

Causes

- Dislocation of the patella may result from a direct force applied to the anterior medial aspect of the patella, driving it laterally (see Figure 36-5 Dislocation of the patella). However, it most frequently occurs in the absence of trauma, in younger individuals with developmental weakness of the patellar mechanism.

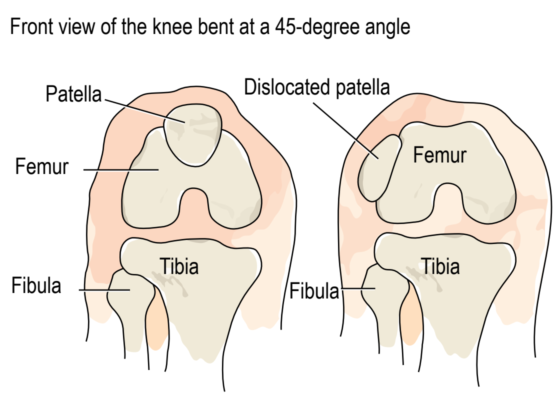

Figure 36-5 Dislocation of the patella

- Incomplete dislocations usually reduce spontaneously when the knee is extended. This may also occur with complete dislocation. After spontaneous reduction, there is usually swelling of the anterior knee with marked tenderness along the medial border of the patella.

Signs and symptoms

Indications of a patella dislocation may include the following:

- Knee is semi-flexed
- Patella is displaced laterally
- Quadriceps and patella tendons are taut

Management

- Support the limb in the position found, conduct the primary survey and assist the patient into an appropriate position as outlined on page 24, Positioning the Patient for the Primary Survey.
- Maintain any flexion of the knee with padding placed behind the knee.
- Examine the limb as outlined on page 245, Principles of Examination of Limb Injuries.
- Cool the knee with ice to reduce discomfort.
- Immobilize the limb as outlined on page 248, Principles of Immobilization as for a fracture of the knee with support provided posteriorly to maintain any flexion of the knee (see Figure 36-6).

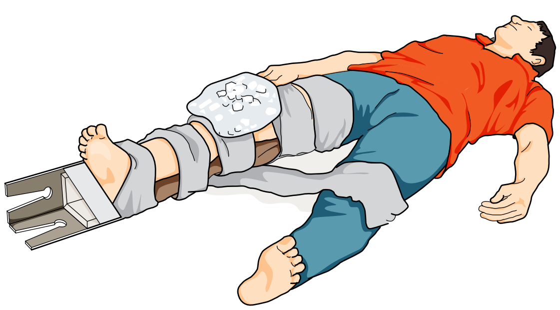

Figure 36-6 Immobilization for a dislocation of the patella

Knee sprains

The knee is very prone to injuries of the ligaments, which may range in severity from simple sprains to a complete tear of one or more of the major ligaments. The four main ligaments of the knee (see Figures 36-7 and 36-8) in order of their vulnerability to injury are:

1. medial collateral
2. anterior cruciate
3. lateral collateral
4. posterior cruciate

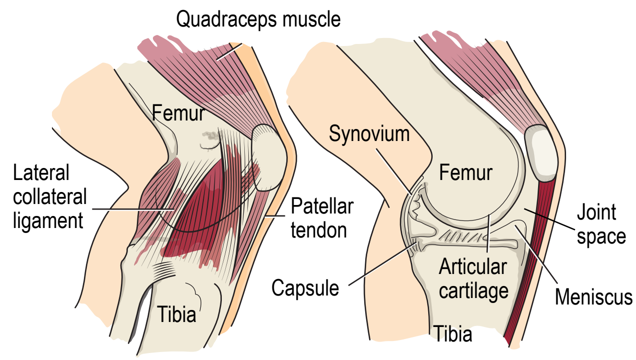

Figure 36-7 Structures of the knee

Causes

Ligament injuries occur when abnormal twisting or bending forces are transmitted to the knee causing excessive rotation, which may tear any or all of the ligaments.

It is not uncommon for the medial collateral ligament, the anterior cruciate ligament, and the cartilage to be injured together, as excessive rotation can damage all of these structures.

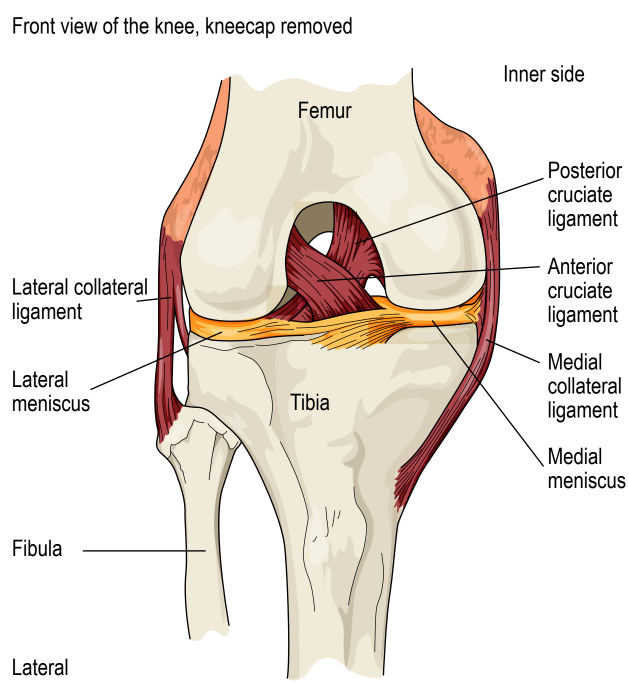

Figure 36-8 Ligaments of the knee

The most frequently injured ligaments of the knee are the medial collateral ligament and the anterior cruciate ligament. These two can be injured when the foot is planted firmly and the knee is struck from the lateral aspect. The condyle of the femur is driven into the meniscus, the anterior cruciate ligament becomes overstretched, and the medial collateral ligament is torn. Swelling is immediate. Damage to the surrounding bursae, blood vessels, and nerves may occur.

Signs and symptoms, and management

Sprains to the knee range in severity from mild to severe:

- In a mildly sprained knee, the pain may be relatively insignificant. There will be little or no swelling. There are usually no complications, and treatment consists of the application of cold and a tensor bandage.
- In a moderate knee sprain, there is more pain and some swelling in the knee, with possible hematoma formation. The patient may be unable to bear weight at the time of the injury or within the next 24 hours as the swelling increases. First aid treatment for a moderate knee sprain includes the application of cold and a tensor bandage. Have the patient use crutches, if available, and refer the patient to medical attention.
- A severe knee sprain is one in which the pain, swelling, and inability to bear weight are immediate and any movement can increase the pain. Sometimes severe sprains are associated with dislocation of the knee or patella, or tears of the ligaments of the knee. First aid treatment includes the application of cold, immobilization in the position of most comfort, and transport to medical aid.

Cartilage tears

The medial and lateral menisci lie on the superior surface of the tibia. In cartilage injuries, the point of tenderness is likely to be on the joint line. In ligament injuries around the knee, the point tenderness may be felt above or below the joint line.

Causes

Menisci injuries may be caused by a compression or grinding action of the femur on the tibia, with some cartilage interposed between. The injury that damaged the ligaments may also damage the cartilage. Once torn, the cartilage will not repair itself.

Signs and symptoms

Indications of a cartilage tear of the knee may include:

- The patient may have felt a clicking, snapping, or tearing sensation in the knee.
- A torn cartilage usually swells, caused by increased synovial fluid or blood in the joint. The swelling may take a few hours to appear.
- The knee may be locked or may give way.
- Chips of cartilage may float loosely in the joint and form wedges which will lock the joint in a certain position.
- A patient who has had a knee cartilage injury may find subsequently that the knee will lock spontaneously, usually in a flexed position. Sometimes a patient can unlock it himself or herself. If this condition occurs, such patients should be referred for medical attention.

Management

- Cool the knee with ice to reduce discomfort.
- Elevate the knee in a position of comfort — usually semi-flexed.
- Discourage weight bearing.
- Immobilize as necessary.
- Refer the patient for medical attention.

Bursitis of the knee

There are numerous bursae in and around the knee joint. They secrete fluid and lubricate the joint, absorb shock, and prevent wear by friction. When irritated, the bursae may fill with synovial fluid.

Causes

Bursitis of the knee is most often caused by:

- A blow to the knee
- Prolonged pressure on the bursae, such as from prolonged kneeling

Signs and symptoms

- Indications of bursitis of the knee may include:
- Superficial synovial swelling on or just inferior to the patella
- Local pain, especially when kneeling

Possible complications

Continued irritation and continued swelling may damage the bursae and joint structures.

Management

- Control swelling with cold and elevation.
- Ensure minimal knee movement and do not allow the patient to continue to kneel.
- Apply crepe for support.
- Refer to medical attention, if required (see page 214, Referral to Medical Aid).

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Lower leg fractures (tibia/fibula)

Fractures of the lower leg may involve the tibia or the fibula or both. Because of the relatively large amount of soft-tissue support surrounding the fibula, fractures of this bone are generally closed. The tibia lies immediately under the skin of the shin and, consequently, these fractures are more often open.

Signs and Symptoms

- In addition to the general signs of a fracture, indications of a lower leg fracture may include:
- Severe pain
- Deformity
- Shortening of the lower leg
- Swelling at the injury site, whether the fracture is closed or open

Possible Complications

- Complications of lower leg fractures may include:
- Blood vessel damage
- Nerve damage

Management

- Support the limb in the position found and assist the patient into an appropriate position as outlined on page 24, Positioning the Patient for the Primary Survey. Examine the limb as outlined on page 245, Principles of Examination of Limb Injuries.
- Immobilize the limb as outlined on page 248, Principles of Immobilization.
- Apply appropriate-length splints or other means of immobilization and if possible, avoid placing immobilization devices over wounds, swelling, or obvious deformity. The joints above and below the site of the fracture must be immobilized.

Ankle fractures and dislocations (lower-third tibia/fibula, ankle)

Ankles that are badly deformed usually have a fracture dislocation of the joint.

Signs and Symptoms

In addition to the general signs of a fracture, indications of an ankle fracture or dislocation may include:

- Pain
- Deformity
- Swelling at the injury site, whether the fracture is closed or open

Possible complications

Complications of ankle fractures and dislocations may include:

- Blood vessel damage
- Nerve damage

Management

- Ankle injuries — fractures or dislocations — are managed as any other joint injuries:
- Support the limb in the position found, conduct the primary survey and assist the patient into an appropriate position as outlined on page 24, Positioning the Patient for the Primary Survey.
- Examine the limb as outlined on page 245,
- Principles of Examination of Limb Injuries.
- Immobilize the limb as outlined on page 248, Principles of Immobilization.
- Apply appropriate-length splints or other means of immobilization and if possible, avoid placing immobilization devices over wounds, swelling, or obvious deformity. A plantar splint may also be needed for added support to the ankle joint. The joints above and below the site of the fracture must be immobilized (see Figure 36-9).

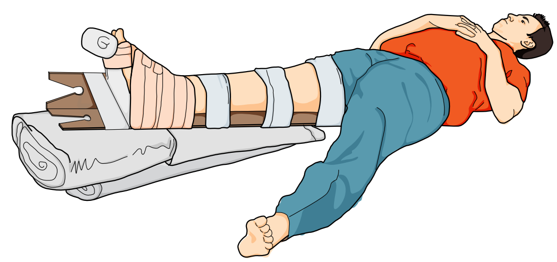

Figure 36-9 Immobilization for fracture of the ankle

Ankle sprains

The ankle joint is one of the most frequently injured joints. On initial examination, it may be difficult to differentiate a simple sprain from an undisplaced ankle fracture.

Cause

Ankle sprains are caused by inversion or eversion of the foot.

Signs and symptoms

- Pain will be more acute on the injured side or, during a range of motion check, when movement is in the direction that stretches the injured ligament.
- The patient is reluctant to place weight on the injured ankle.
- Swelling usually appears shortly after the accident.
- If ligaments are torn, discolouration will appear in one to two days.
- A severe sprain will be indicated by:
  - Widespread swelling
  - Inability to bear weight
- A simple sprain will be indicated by:
  - Minimal localized swelling
  - The ability to bear weight without severe pain
  - No deformityy

Management of severe sprains

- Control the swelling with elevation, cold, and a crepe bandage and transport to medical aid.
- If you are unsure of the severity of the injury, treat as for an ankle fracture.
- In isolated or semi-isolated areas, the patient should keep weight off the injured ankle for 24 hours.
- The swelling should be controlled with elevation, cold, and a crepe bandage, as required. If there is no improvement after 24 hours or if significant discolouration appears, the patient should be referred to a physician. If there is improvement and minimal discolouration, support the ankle with strapping and a tensor bandage.

Management of simple sprains

- Control the swelling with elevation, cold, and a crepe bandage as required.
- Encourage moderate activity if the patient can maintain weight on the injured ankle.
- Alter work activity if necessary — e.g., light duty.
- Refer the patient to medical aid if there is no improvement in three days.

Injuries of the foot and toes

Injuries of the foot and toes are very common. The most frequent mechanisms of injury include a crushing force, direct trauma, inversion injury to the lateral foot, and puncture wounds. Other, less common mechanisms include a fall from height onto the heels and lacerations.

It may be difficult to distinguish between a sprain and a fracture of the foot. Injuries of the foot usually swell significantly. Fortunately, vascular injuries are uncommon. As in the upper extremity, lacerations of the foot and ankle may involve associated nerve and tendon damage. A simple puncture wound of the foot, especially if the puncturing object is contaminated (e.g., a pitchfork) may cause a serious and rapidly progressive infection. Such injuries should be assessed medically if the patient is at all incapacitated or if the injury could have complications (e.g., tetanus).

Any fall from a height where the patient lands on the heels may result in a fracture of the calcaneus (heel bone). This injury is very painful and produces marked swelling. The skin around the fracture may blister in the first 24 hours. Immediate elevation and the intermittent application of cold are usually very helpful. With such falls, be sure to assess for an associated knee, pelvic, or lumbar spine injury.

Management

- Lay the patient in the supine position, if not contraindicated.
- Remove shoes and socks with care. They may have to be cut off.
- A pillow or blanket-splint, may provide immobilization of the foot for suspected foot fractures. Otherwise, use the splinting techniques outlined in ankle fracture section.

Part 11

Environmental Emergencies

Part 11 Environmental Emergencies

Exposure to heat and cold

The human body is able to maintain a steady core temperature of 37°C (98.6°F) despite exposure to a wide range of environmental conditions, because it has a number of mechanisms to stabilize internal body temperature. The body has to dissipate heat when working or exercising in a hot climate. Working muscle generates considerable amounts of heat. Heavy exertion on a very hot day could theoretically raise the body's core temperature to a fatal level if not for the body's capability to dissipate heat.

Extreme cold, just like extreme heat, has the potential to cause injury and damage to tissue. Body cells can function only within a narrow temperature range. If the core temperature falls below a critical point, severe organ dysfunction begins.

This chapter covers environmental emergencies and disorders associated with heat exposure and extreme cold.

Mechanisms of heat loss

Heat dissipation (loss) occurs through the following mechanisms:

- Radiation
- Conduction
- Convection
- Evaporation

Radiation is the transfer of heat without direct contact. It is an effective means of heat loss provided that the surrounding temperature is less than the body's core temperature (37°C or 98.6°F). When the outside temperature is close to the body's core temperature, heat loss through radiation is minimal. When the outside temperature exceeds the core temperature, the body actually absorbs additional heat from the environment rather than losing heat.

Conduction is the transfer of heat by direct contact. Anyone who has touched cold metal with bare skin on a cold day may painfully remember this particular effect of conductive heat loss.

Convection directly transfers heat only if cooler air or water passes over the warm body. On a windless day, or if the patient is well-insulated with bulky windproof clothing, heat loss by convection is minimal or non-existent.

Evaporation of sweat is the body's only effective mechanism for heat loss when the surrounding temperature is close to or higher than the normal body temperature. However, if the humidity is very high, evaporation is reduced. Individuals who exercise or work hard on hot, humid, windless days are especially prone to disorders associated with heat exposure.

Workers and athletes can produce as much as 2.5 to 3 L (4.5 to 5.5 pt.) of sweat per hour during periods of extreme exertion. Sweat is a solution of water and salt. As a result of profuse sweating, an individual may become dehydrated and salt depleted. This can lead to heat cramps or heat exhaustion. The problem is further complicated when the individual replaces the fluid loss with alcoholic beverages or drinks containing caffeine. Alcohol and caffeine are diuretics, which cause the body to lose additional fluid through increased urine production.

If the body is unable to dissipate heat, the core body temperature may rise to critical levels. Mild or moderate elevation of core temperature commonly occurs as fever, and is usually associated with infection and other illnesses. Heatstroke (hyperthermia) is a life-threatening elevation of the body's core temperature above 41°C (106°F), usually associated with a decreased level of consciousness and cardiovascular collapse.

Heat cramps

Heat cramps result from salt imbalance in muscle. They occur when patients sweat profusely during a period of heavy exertion and replace their fluid losses but not their salt depletion.

Severe, intense muscle cramps occur in those muscles that have performed the most work — usually in the arms or legs. The onset is often delayed, so that cramping usually occurs during a resting period. There is no evidence that muscle injury occurs as a result of cramps. The core body temperature of a patient with heat cramps is usually normal. The patient's vital signs are typically normal, and there is no change in their level of consciousness.

Treatment focuses on fluid and salt replacement. Commercially available oral rehydrating solutions or fruit juices are useful. A solution of 1 teaspoon of salt to 0.5 L (500 cc, or 1 pt.) of water is also recommended. Pure water or alcoholic beverages are contraindicated. Salt tablets are not recommended because they often pass through the bowel undigested and may cause vomiting.

If the patient has abnormal vital signs or a decreased level of consciousness, the attendant must consider other heat-related disorders or other medical problems.

Heat exhaustion

Heat exhaustion is caused by depletion of both water and salt, due to sweating during prolonged periods of exertion, when fluid replacement has not been sufficient to match the losses.

Signs and symptoms of heat exhaustion

The signs and symptoms of heat exhaustion may develop over a relatively short period of time in workers who, during extreme exertion, do not drink fluids. They may also take a few days to develop — e.g., in elderly patients in nursing homes, who may develop heat exhaustion during prolonged heat waves because of their inability to maintain adequate fluid replacement.

Patients may display some or all of the following signs and symptoms:

- Shallow respiration
- Increased respiratory rate
- Weak rapid pulse
- Cool, pale, and clammy skin
- Sweating
- Weakness, fatigue, or dizziness
- Headache and nausea
- Fainting
- Muscle cramps

The signs and symptoms of heat exhaustion are essentially those of mild hypovolemic shock. The presence of sweating is an important finding because it is often the only way to differentiate heat exhaustion from the life-threatening emergency of heatstroke. If untreated, heat exhaustion may progress to heatstroke.

Management of heat exhaustion

The essentials of heat exhaustion management are to follow the priority action approach and cool the patient.

1. Conduct the scene assessment.
2. Conduct a primary survey and perform necessary critical interventions.
3. Move the patient to a cooler environment, lay them down and remove or loosen excess or tight-fitting clothing.
4. Conduct a secondary survey.
5. Cool the patient by sponging them with cool water and fanning. Take care not to cool the patient too much. If the patient begins to shiver, stop sponging and fanning.
6. If the patient is fully alert and not nauseated, provide oral fluids. Juice, non-caffeinated soft drinks, commercially available oral rehydrating solutions, or a solution of salt water — 1 teaspoon of salt to 0.5 L (1 pt.) of water — are best. Alcoholic and caffeinated beverages are not recommended.

In most cases, the patient's symptoms will improve dramatically within 30 minutes. These patients should still be transported to medical aid.

Heatstroke

Heatstroke (hyperthermia) occurs when the body's mechanisms for heat dissipation are overwhelmed and fail. Heatstroke must not be confused with thermal injury (e.g., burns). With heatstroke, as a result of heat exposure, the core body temperature rises to critical levels approaching or exceeding 41°C (106°F). At these high temperatures, the cells of the brain, heart, and kidneys are unable to survive and organ dysfunction develops. Heatstroke typically develops during periods of extreme exertion in a hot, humid environment. The risk of heatstroke is increased by inadequate fluid and salt intake. Certain medications may also increase the risk of heatstroke. Some drug overdoses may cause heatstroke as a symptom of the poisoning. During long heat waves, elderly people living in non-air-conditioned, poorly ventilated buildings are at risk.

Signs and symptoms of heatstroke

As the body's core temperature rises to critical levels, organ dysfunction develops, especially in the heart and the brain. Therefore, most signs and symptoms of heatstroke reflect the cardiovascular and nervous systems. Patients may display some or all of the following signs and symptoms:

- Hot, dry, flushed skin
- Absence of sweating (classic Heatstroke)
- Profuse sweating (exertional Heatstroke)
- Agitation, confusion
- Decreased level of consciousness
- Headache
- Nausea and vomiting
- Seizures
- Increased respiratory rate
- Irregular pulse
- Shock
- Cardiac arrest

The presence of hot, dry, flushed skin without any evidence of sweating is one of the important findings that differentiate heatstroke from other heat-related illnesses. The lack of sweating attests to the body's inability to compensate for the heat stress because its compensatory mechanisms have been overwhelmed. The presence of profuse sweating, combined with exposure to high temperatures (40+ degrees), and an altered level of consciousness, may indicate exertional heatstroke.

Recognition of severe heatstroke is not difficult when a patient exhibits the classic signs of elevated body temperature and altered level of consciousness, in the midst of a heat wave or after heavy exertion on a very hot humid day. However, in a temperate climate, the signs and symptoms may not be typical and may not be recognized until a core temperature is recorded.

Management of heatstroke

Heatstroke is a life-threatening medical emergency and the patient is in the rapid transport category. Without prompt and aggressive treatment, the patient may die. The attendant must make every effort to lower the body's core temperature while awaiting transport and continue efforts en route.

1. Conduct the scene assessment.
2. Conduct the primary survey and any interventions.
3. Move the patient to the coolest spot available (e.g., place them in the shade).
4. Place the patient supine unless there is active vomiting or seizures. In this situation, the ¾-prone or lateral position is recommended.
5. Remove all outer clothing.
6. Apply cold water to the patient either by dousing — being careful to protect the patient's airway — or by applying wet, cool sheets. Spraying or sponging the entire body with cold water is also effective. Fan the patient to promote evaporation and increase the cooling rate; this is very effective if combined with a cool wet sheet over them.
7. If the patient is fully alert and not nauseated, provide oral fluids. Juice, non-caffeinated soft drinks, commercially available oral rehydrating solutions, or a solution of salt water — 1 teaspoon of salt to 0.5 L (1 pt.) of water — are best. Alcoholic and caffeinated beverages are not recommended.
8. Patients with heatstroke require urgent medical aid and are in the rapid transport category. Transport the patient to medical aid and instruct helpers to continue the cooling during packaging and en route.
9. If possible, a core temperature should be measured and recorded — a specific type of thermometer is required for measuring core temperature, see page 274, Diagnosing Hypothermia. Cooling measures should be stopped when the temperature falls to 38.5°C (101.3°F) measured rectally or if a rectal measurement is not practicable, with a tympanic thermometer in the external auditory canal.
10. Conduct the secondary survey.
11. Protect the patient with seizures from further injury while cooling continues. An oral airway and assisted ventilation may be required, especially in the postictal period (see page 134, Grand Mal Seizures).

The most important aspect of heatstroke and other heat-related illnesses is prevention. The attendant has an important role to play in preventing these medical problems. By teaching co-workers about the risk of heat-related illness and encouraging adequate salt and fluid replacement on hot summer days, the attendant may prevent such emergencies from happening.

Cold injury and immersion foot

Cold injury and immersion foot (trench foot), frostnip and frostbite, and hypothermia are the major categories of cold injury.

Cold injury and immersion foot are usually mild injuries with no long-term damage to the soft tissue. Cold injury occurs as the result of prolonged exposure to cold — not necessarily freezing temperatures. Immersion foot occurs from prolonged exposure to cold water and is particularly common among hikers and hunters. The skin of the affected part is pale and cold to touch but does not feel frozen. Sensation is usually preserved to some extent. These signs and symptoms distinguish milder injuries from frostbite.

The emergency treatment of mild cold injuries focuses on removing the patient from the cold, wet environment and rewarming the affected part. Wet and/or constrictive clothing must be removed. Contact with a warm object such as the attendant's hands or the patient's own axilla is all that is usually required. Tingling, mild pain, and redness of the affected part usually occur during rewarming. The affected part usually heals completely on its own without further treatment. The patient should be referred for medical assessment if the symptoms persist.

Frostnip and frostbite

Frostbite and frostnip occur when soft tissue is subjected to freezing temperatures.

Frostnip is defined as a minor cold injury without soft-tissue damage, whereas frostbite is defined as a cold injury with damage to the soft tissues, most commonly involving the lower extremities.

Tissue injury (frostbite) results when tissue temperature falls below a critical point. The tissue temperature is affected not only by the outside temperature and wind-chill factor, but also by the blood flow to the tissue. Patients with pre-existing circulatory disorders are more susceptible to frostbite. Workers wearing constrictive clothing or who must work in cramped positions have reduced blood flow to the extremities and are also more susceptible to frostbite.

With frostbite, ice crystals form within the tissues. In addition, as the hands or feet — the most common sites — are cooled, the blood vessels of the skin constrict and blood flow is reduced significantly.

Ultimately, the affected tissue, including its blood vessels and nerve fibres, is damaged.

Signs and symptoms of frostbite

The toes are the site most commonly affected by frostbite. The symptoms will vary with the individual and the outside (ambient) temperature. Generally, symptoms begin with pain and redness. The redness represents the body's efforts to increase tissue temperature by increasing the blood flow to it. As the cold progresses, the affected part becomes pale and the pain is replaced by tingling and numbness. Patients often describe the affected part as feeling like a block of wood. The frozen extremity may appear completely white or be mottled with blue and white patches. The affected tissues feel frozen solid to the touch.

It is impossible to determine the full extent of injury during the initial assessment. A severe frostbite may initially resemble a superficial mild injury but could ultimately require amputation.

Management of frostbite

Use the priority action approach to assess and prioritize the patient's injuries. The ABCs are obviously the first priority. Frostbite by itself does not cause alteration of the ABCs. If the patient has a decreased level of consciousness, airway or breathing problems, or signs of shock, diligently search for other injuries and also consider the possibility of severe hypothermia. Do not let a frostbite injury distract attention from other potentially life-threatening injuries.

Remove any wet or constrictive clothing from the affected extremity. Take care not to expose the extremity to further cold. If the patient cannot be moved indoors, apply a dressing and wrap the extremity in dry blankets. The use of snow or ice packs is not appropriate as it increases the extent of the frostbite injury.

Never rub frost-bitten tissue, because doing so increases the extent of injury.

Lightly cover the affected part with sterile gauze dressings. Do not break any blisters. Elevate the limb to heart level and immobilize it with a padded splint.

Handle the limb gently. If a foot is affected, do not allow the patient to walk or bear weight. Transport the patient to medical aid.

The objective of therapy is to rewarm the affected part. Rewarming should be done once and only once, as quickly as possible, and usually is best done in the hospital. Equipment limitations and time factors are the major problems with rewarming by attendants in the field.

Initiate rewarming therapy only if transportation to a hospital is delayed for more than 1 hour and all the necessary equipment is available.

Technique for rewarming frostbitten tissue

1. If the frostbitten part is a hand or foot, immerse it in a large basin or bath of warm water, 38°C to 43°C (100.5°F to 110°F). The bath or basin has to be large enough that the affected part does not touch the sides and there is still sufficient room to stir the water.

2. Check the initial water temperature with a thermometer and monitor the temperature closely. The water will cool rapidly and additional hot water must be carefully added to maintain the temperature within the desired range.
3. The thawing or rewarming process usually takes 30 to 40 minutes.
4. If the ears or parts of the face are affected (see Figure 37-1 Cold injury), apply warm-water-soaked dressings at the appropriate temperature for 30 to 40 minutes.
5. After rewarming, pat dry the affected part carefully and lightly dress it with dry sterile gauze. If the affected part is a limb, keep it elevated.
6. Never thaw frostbitten tissue by putting it near an open flame or a radiating heat source — e.g., engine exhaust, radiator.
7. Never initiate rewarming if there is any chance that the affected part may freeze again before the patient reaches hospital.

Figure 37-1 Cold injury

As the part rewarms, the patient may experience considerable pain. The patient should be reassured that the pain is normal and a good sign indicating that the affected part will recover. Swelling and blisters may also form within a few hours after rewarming. If blisters form, especially bloody blisters, then the patient should be referred to a physician. Occasionally treatments are available — frostbite can result in amputation. The attendant should be concerned.

Hypothermia

Hypothermia is defined as a core body temperature of less than 35°C (95°F). Normal body temperature is 37°C (98.6°F). Under normal circumstances, the body maintains a stable internal core temperature by balancing heat loss and production.

The body prevents heat loss by constricting the blood vessels to the skin, which reduces the skin's blood flow. The body increases its internal heat production by shivering. The energy generated by shivering is used to maintain the body's core temperature. However, in moderate and severe hypothermia, with the onset of changes in the level of consciousness, shivering is inhibited so heat loss continues unabated.

Hypothermia has many different causes. Outdoor workers are particularly at risk if they are not wearing adequate clothing or if the weather changes suddenly. Exhaustion from hard work and exercise in a cold, wet environment will also increase the risk. Immersion hypothermia may occur when an individual falls into cold water. Patients who are intoxicated with alcohol or drugs risk developing hypothermia if they lose consciousness in a cold environment. Alcohol and drugs interfere with the body's shivering mechanism and induce vasodilation, thereby increasing blood flow to the skin, which increases heat loss. Trauma patients may develop hypothermia as a complication of their injuries. Patients with shock or brain and spinal cord injuries are particularly at risk. Young children and babies are more susceptible to hypothermia because of their larger surface-area-to-weight ratio. Elderly people who are chronically ill are prone to developing hypothermia because their bodies cannot regulate temperature as well.

Mechanisms of heat loss

The body loses heat by four mechanisms:

1. Radiation
2. Conduction
3. Convection
4. Evaporation

Radiation

All objects radiate heat. Radiation is the transfer of heat without direct contact. Radiation accounts for 50 to 65% of the body's heat loss.

Stages of hypothermia

As the body's core temperature falls, the patient's signs and symptoms will change. Hypothermia affects primarily the brain and cardiovascular system. An average/normal body temperature measured orally (by mouth), is 37°C (98.6°F).

Table 37-1 illustrates the clinical stages of hypothermia as the core temperature drops.

- Mild hypothermia refers to a core temperature between 35°C and 33°C (95°F and 91°F).
- Moderate hypothermia occurs between 32°C and 29°C (90°F and 84°F).
- Severe hypothermia occurs at 28°C (83°F) and below.

The attendant should be able to classify the patient's level of hypothermia on the basis of the physical findings.

Diagnosing hypothermia

Using Table 37-1, the attendant should be able to estimate the degree of hypothermia. Patients who are cold but alert and fully oriented, without any signs of confusion or inappropriate behaviour may be classified as mildly hypothermic. It is not usually necessary to record such a patient's temperature. The recording of core temperatures, in moderate or severe hypothermia, is recommended. Documentation of an accurate core temperature by the attendant is often useful in hypothermia.

Oral temperatures are inaccurate and do not reflect core temperatures. The attendant must never rely on an oral temperature to diagnose hypothermia. If a hypothermia thermometer is not available or taking a rectal temperature is not practicable in the circumstances, taking a temperature using a tympanic thermometer is a reasonable alternative. (see Figure 37-2 Tympanic thermometer) A tympanic thermometer is designed to fit into the ear canal and uses infrared energy to accurately measure the core temperature.

The small cone-shaped end of the thermometer is placed in the external ear canal and, within seconds, body temperature shows on the digital display. Fever thermometers accurately record temperatures only down to 35°C (95°F). Special low-reading thermometers are required. If there is a risk of hypothermia in the work environment, a low-reading thermometer should be available.

Figure 37-2 Tympanic thermometer

Priority action approach to the patient with hypothermia

The treatment of a patient with suspected hypothermia follows the priority action approach beginning with the scene assessment and the primary survey.

Scene assessment

Because of dangerous conditions (e.g., weather, avalanche) the person may have to be rapidly extracted to a safe environment prior to the initiation of any assessment or treatment.

Primary survey

The attendant conducts a primary survey, focusing on the ABCs. If the patient is in an avalanche, assess the mouth for impacted snow. Ultimately, these patients may appear to be in cardiac arrest, with absent pulses and respiration. Because this patient is very cold, their metabolic demands will be lower. In this situation, the attendant has the time to feel for a pulse. The attendant should assess the carotid pulse and breathing for 30 seconds to accurately detect the presence of respiration and pulse. Assisted ventilation may have to be provided, but the patient must not be hyperventilated. Assisted ventilation, if required, should be provided at a rate of 6 breaths per minute.

Peripheral pulses become progressively more difficult to palpate as the patient develops vasoconstriction and slowing of the heart rate. This occurs as the degree of hypothermia increases.

The patient with moderate or severe hypothermia who is not in cardiac arrest is particularly at risk of developing cardiac arrest from rough handling.

Stages of hypothermia

Stage of Hypothermia	Temp.	Physical Findings
	37°C	Normal body core temperature
Mild	35°C 34°C 33°C	Hypothermia occurs with a core temperature below this point. Shivering is present to maximize heat production. Vasoconstriction of the peripheral arteries occurs in an attempt to minimize further heat loss and protect the core.
Moderate	32°C 31°C 30°C 29°C	The patient becomes confused and demonstrates inappropriate behaviour. The level of consciousness progressively decreases. Shivering is inhibited. The heart rate slows and irregularities of the heartbeat may be detected. The respiratory rate falls. The pulses may become difficult to palpate. The patient has a high risk of developing cardiac arrest, especially with rough handling. Pupils may be dilated.
Severe	28°C 27°C 26°C 24°C 22°C 16°C 9°C	Coma may develop, as well as increased muscular rigidity. The heart rate slows and the pupils may be dilated and poorly reactive. The respiratory rate decreases further. The patient may appear to be in cardiac arrest, with absent pulses and no respiration. There may be no response to painful stimuli. Patients are usually unresponsive; cardiac arrest may develop. Frothy sputum may appear. This represents fluid congestion in the lungs. At this temperature, there is a maximum risk of cardiac arrest. Lowest accidental hypothermia survivor. Lowest induced hypothermia survivor.

Table 37-1

Hypothermia has a protective effect on the brain and heart. These patients may survive long periodsin cardiac arrest. Patients in cardiac arrest from hypothermia has a protective effect on the brain and heart. These patients may survive long periods in cardiac arrest. Patients in cardiac arrest from hypothermia — and not asphyxia, trauma, or other causes of cardiac arrest — are not dead until they are warm and dead.

Obviously, the attendant must control any severe external bleeding with direct pressure.Hypothermia patients often have associated injuries or other medical emergencies; the attendant must never overlook these.

Management of mild hypothermia

The attendant follows these general principles:

1. Conduct the scene assessment.
2. Conduct the primary survey and perform critical interventions. Patients with mild hypothermia alone should not require critical interventions. If the patient's status deteriorates — e.g., decreased level of consciousness, respiratory distress, decreased peripheral pulses — consider the presence of other injuries that may not have been initially apparent. Frequently reassess these patients and upgrade them into the rapid transport category if necessary.
3. Minimize further heat loss. Remove all wet clothes and replace with dry clothing if available. Wrap the patient in warm blankets and/or a sleeping bag. Move the patient to a warm environment as soon as possible. In the first aid room, turn up the heat as high as possible. In the ambulance or another transport vehicle, turn up the heater and warm the vehicle.
4. If the patient has mild hypothermia (e.g., not confused), they have no real risks of core temperature after-drop reactions. If the patient feels good walking to warm up, allow them to do so.
5. Conduct the secondary survey.
6. Do not suppress shivering even if it appears violent. This is the most effective way that the body has to generate heat. Calmly reassure the patient.

7. Do not give the patient any stimulants (coffee, tea) or any alcohol. Hot, non-alcoholic drinks containing sugar may provide needed energy, and may make the patient feel better. Hot fluids may be given only when the patient is fully alert and oriented without any signs of confusion. Patients with moderate and severe hypothermia have a very high risk of vomiting. Fluids must not be given to these patients.
8. Do not massage the extremities or the trunk.
9. Do not put the patient in a warm bath or shower.
10. The application of hot packs is very controversial. Patients with mild hypothermia may benefit from the careful application of warm pads or hotwater bottles behind the patient's neck (unless a cervical spine injury is suspected), in the groin, and in the axillae. Patients with moderate to severe hypothermia should not be treated in this way as they have a higher mortality rate than those treated without hot packs. Furthermore, hot water bottles or hot pads have the potential to burn the patient.

Management of moderate and severe hypothermia

Patients with moderate and severe hypothermia have a decreased level of consciousness and variable changes in the heart and respiratory rate. The attendant's first priority is management of the ABCs. Patients with a decreased level of consciousness and a history of a fall will require motion restriction of the cervical spine.

1. Conduct the scene assessment. Activate the workplace emergency response procedures as required.
2. Conduct the primary survey. As with any other seriously ill patient, maintain the airway, ensure adequate ventilation, and circulation.
3. Conduct a careful assessment for respiration and the presence of a carotid pulse; this assessment should take up to 30 seconds. If breathing and the carotid pulse are absent or the attendant is not sure whether the patient is breathing and has a carotid pulse, it should be assumed that the patient is in cardiac arrest and CPR/AED should be initiated.
4. If assisted ventilation with a pocket mask is required, the patient must not be hyperventilated. Assist the patient's own breathing and interpose ventilations to a total of 6 breaths per minute. If the patient is hypoxic, apply oxygen to the pocket mask and continue.
5. Move the patient to a warm environment as soon as possible while awaiting transport to hospital. Turn the heat up in the (first aid) room. Turn the heater on high in the ambulance or transport vehicle.
6. All patients with moderate or severe hypothermia are in the rapid transport category.
7. Handle the patient gently. Transport the patient on a stretcher. The patient may be violent or try to walk. The patient may have to be restrained, but the attendant must remember that rough handling may precipitate a cardiac arrest.
8. Do not suppress shivering, even if it appears violent. This is the most effective way that the body has to generate heat. Calmly reassure the patient.
9. Prevent ongoing heat loss by removing all wet clothes and replacing with dry coverings. If available, wrap the patient in warm blankets and/or a sleeping bag.
10. It is not necessary to have someone undress and rewarm the patient with direct body contact.
11. Do not give the patient anything by mouth, even warm fluids. Patients with moderate or severe hypothermia are at high risk of vomiting.
12. Do not massage the extremities or the trunk. This may precipitate cardiac arrest.
13. Do not put the patient in a warm bath or shower.
14. Patients with moderate and severe hypothermia must be frequently reassessed. Look for changes in the cardiovascular status as well as evidence of other injuries that were not apparent initially.

Burns

Excessive external heat causes damage to the skin and possibly the underlying structures. It may be dry heat such as fire, friction from a rapidly moving rope, electricity, or a scald from hot liquids or vapours. The severity of soft-tissue injury from heat is directly related to the exposure duration and intensity of the heat. The extent of damage from a burn depends on the size of the area affected and the depth of tissue involved. The larger and/or the deeper the area involved, the greater the effect on the body as a whole.

This chapter provides the attendant with an overview of burn classifications, estimating burn extent and treatment recommendations. The procedures will follow the priority action approach.

Classification of burns

Burns are classified on the basis of the depth of the burn into first, second, and third degree (see Figure 38-1 Depth of burns). A burn injury may include combinations of first-, second-, and third-degree burns.

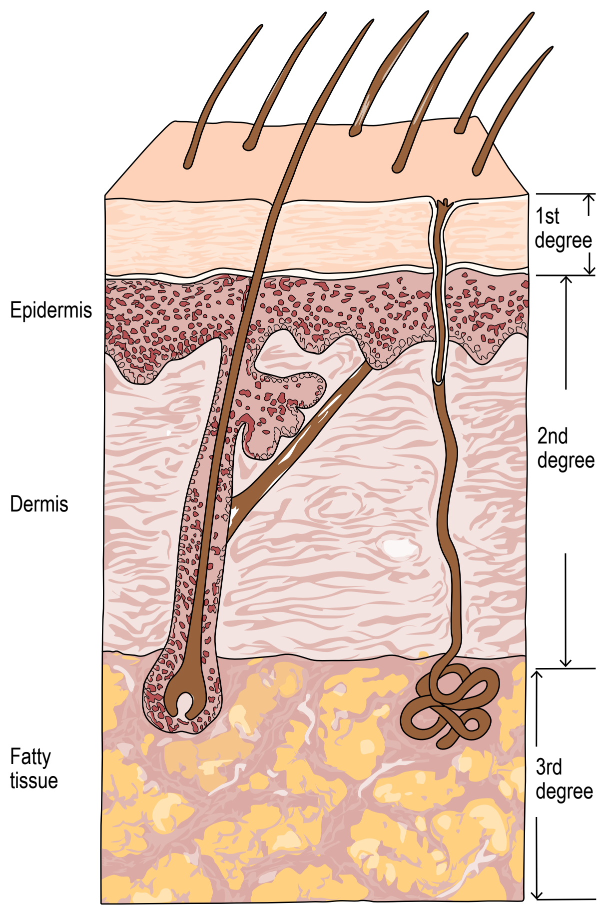

Figure 38-1 Depth of burns

First-degree burns

First-degree burns are those that affect only the outer layer of the skin. A first-degree or partial-thickness burn usually results in reddening of the skin and pain, such as with mild sunburn or a minor scald. This burn is usually painful initially, and then heals in about a week, with possible peeling of the outer skin layer.

Second-degree burns

Second-degree burns can be partial or full thickness. Partial-thickness second-degree burns destroy the epidermis and the superficial part of the dermis layer of the skin. Full thickness destroys the epidermis and most of the dermis, the area still has some intact nerve endings so it is painful, but sensation is often diminished. The significance between a partial- or full-thickness second-degree burn is that full-thickness burns will require skin grafting. Partial-thickness burns will heal without grafting.

In partial-thickness second-degree burns, damage to capillaries causes fluid (plasma) to seep into the damaged tissue, raising the top layer of skin and causing blisters (see Figure 38-2 Second-degree burns). Severe pain is usually present, since nerve endings are irritated and sensitive. Blisters may not appear for several hours after the injury, and the skin may only appear red and mottled — discoloured in patches.

In full-thickness second-degree burns, the blister may be absent and the area initially dry. When the burn is touched, the skin in the area directly beneath the attendant's fingers will blanch, but return of circulation to the skin is sluggish.

Extensive second-degree burns can cause a marked loss of fluid into the blisters and underlying tissues.

The effect on the body will depend on the amount of fluid lost. If the loss is significant, shock may occur. Excessive fluid loss can occur if more than 10% of the body surface has second-degree burns.

Figure 38-2 Second-degree burns

Third-degree burns

Third-degree burns involve damage to the full thickness of the dermis layer of the skin and underlying fat (see Figure 38-3 Third-degree burns). The muscles, bones, and deeper structures may be damaged in third-degree (full-thickness) burns.

Third-degree burns damage the nerve endings so that pain is not a prominent symptom. The burn area may appear charred or may be dry and pale. It may also appear hard, thick, and leathery and it may be either black, dark brown, or white. In spite of the dry appearance, burn patients may lose a considerable amount of fluid from the burn into the tissue spaces of the area around the burn. Shock due to this fluid loss may be a major complication if the burn involves more than 10% of the body surface.

Figure 38-3 Third-degree burns

Determining the extent of burns

Knowing the exact extent of body surface burned is important for subsequent medical treatment. For initial first aid management and transportation of the patient, the attendant need only make a quick estimate of the total extent of burn injuries. This information is important so the attendant can determine if swift transport to hospital is necessary — e.g., if the patient is in the rapid transport category.

The fastest and easiest method of estimating the percentage of body surface burned is the Rule of Nines.

The body is divided into multiples of nine (see Figure 38-4 Rule of Nines). Each upper extremity counts 9%, head and neck together 9%, each lower extremity 18%, the anterior and posterior surfaces of the trunk each 18%, and the perineum and genitalia together 1%. An area the size of the patient's hand can be assumed to be 1%.

- Burns that are considered serious and are in the rapid transport category are:
- Any burn with associated smoke inhalation injury
- Second-degree burns to more than 10% of the body surface
- Third-degree burns to more than 2% of the body surface
- Significant burns involving the face
- Burns encircling a limb
- Major burns to the hands, feet, or genitalia
- All electrical burns
- All chemical burns

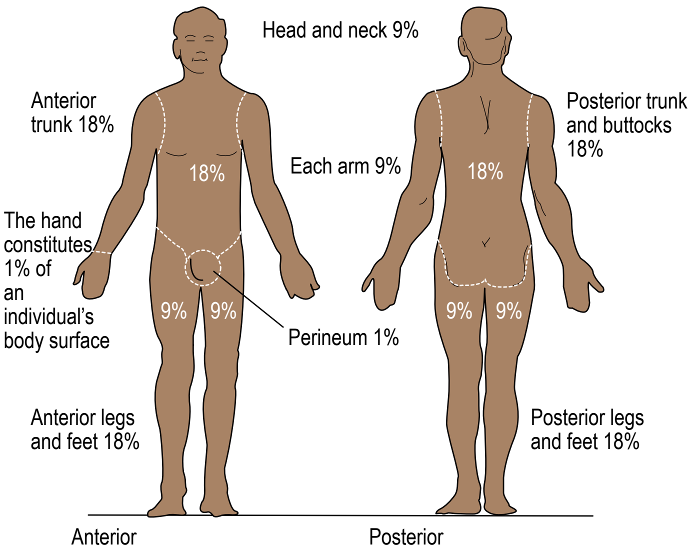

Figure 38-4 The Rule of Nines

Burns that require referral to medical aid include:

- Significant second-degree burns to less than 10% of the body surface
- Third-degree burns to less than 2% of the body surface

Mechanism of Injury for Burns

The history of a burn injury is very important to the physician. If the patient was involved with a sudden flash or scalding liquid, most likely there will be first- and/or second-degree burns. If the patient's clothing caught fire, there may be third-degree burns. If the person was burned in an enclosed space, the result may be respiratory burns or smoke inhalation and lung damage. If there was an explosion, there may be other associated injuries.

Priority action approach for serious burns

First aid management of the burn patient begins at the scene of injury. The attendant should follow the priority action approach outlined on page 18 or the priority action approach to the Walk-In Patient, page 193. The attendant must address the following special considerations when assessing the patient with a major burn injury:

- Ensure no danger; put out the fire.
- Ensure no danger. Put out the fire.
- Remove the patient from the heat or the heat from the patient. Some patients have arrived at hospitals with their clothes still smouldering under dressings and bandages. If the clothing is on fire, the patient must be laid down and the flames smothered by rolling the patient in a blanket or by dousing them with large quantities of water.
- Carefully remove all clothing that is still smouldering or retaining heat.

Airway and Respiration

The single most important initial consideration is the patient's airway. Is the patient breathing and, if so, is the breathing adequate?

Respiratory problems must be anticipated in the following cases:

- The patient has or had a decreased level of consciousness.
- The patient was burned indoors — in an enclosed space
- The patient has facial burns or soot around their mouth and nose.
- The patient has been exposed to smoke or hot gases.

Inspect the patient's face and neck for early signs of swelling. Inspect the nose and lips for burned or singed nasal hairs, lip blisters, and soot in the mouth. Have the patient cough and look for soot in the sputum. Look for swelling of the patient's tongue or air passages.

Hoarseness, stridor, cough, difficulty swallowing, and shortness of breath all suggest a smoke inhalation injury. All patients with smoke inhalation injury require supplemental oxygen by face mask at 10 L/min.

For patients with complete or partial airway obstruction, refer to Airway Management: Procedures for Clearing the Airway on page 58. If the patient is having difficulty taking a breath and is unresponsive to verbal stimuli, insert an oral airway. Assist ventilation if needed according to the criteria on page 60.

Circulation

Burns do not bleed. However, hypovolemic shock often develops as a result of fluid loss through burned tissues or other associated injuries. Rescuers often overlook underlying injuries in patients who have major burns.

Major burn wound management

1. Cooling may limit the depth of the burn for some first- and second-degree burns — e.g., from a propane flash or scald. Cooling is soothing and provides some pain relief for all types of burns. Cooling should start within 5 minutes of the burn and be applied for a maximum of 20 minutes. A helper can continue the cooling during RTC packaging or the secondary survey. Cooling should be limited to 20% of the body surface. Cooling of a greater portion of the body surface can cause hypothermia. Never apply ice. Any available source of water may be used — e.g., tap water from a kitchen sink or a garden hose. Sterile water or saline solution is neither superior to tap water nor necessary.
2. If water is used to put out the fire, the patient's entire body may have to be covered. This is done to put out the fire but should not be prolonged. In these circumstances, once the fire is out, wet and burned clothing should be removed. Do not cool more than 20% of the body surface except to extinguish flames.
3. Remove burned clothing to ensure all smouldering or melting fabric is no longer in contact with the skin.
4. Remove rings, wrist watches, and footwear, if possible.
5. Elevate burned extremities, if possible. This may decrease fluid loss and tissue swelling. Do not splint burned limbs unless there is an obvious fracture or dislocation.
6. Do not break blisters.
7. Do not apply creams, ointments, or topical anaesthetics to burns.
8. Apply wet dressings on burns to less than 20% of the body surface. Any burn in excess of 20% can be covered with dry dressings or clean sheets. Do not apply tight, encircling dressings.
9. After the burns are dressed, keep the patient comfortable and cover him or her with blankets if necessary.
10. Monitor the patient's ABCs frequently en route to the hospital.

Minor burn care

First-degree burns

Unless a first-degree burn has involved a very large area (e.g., 40% to 50%) of the body surface, a patient with a first-degree burn usually does not require hospitalization. The principal problem in first-degree burns is pain, which can be relieved by cold water compresses. These should be applied only to a maximum 20% of the body surface at any one time. Cold towels are usually effective for burns of the trunk or face. Stop the cooling if the patient starts to shiver.

Partial-Thickness Second-Degree Burns

The principal problems with second-degree burns are infection, pain, and shock caused by loss of fluid into blisters. Treatment is similar to that of a first-degree burn. Cooling applied within five minutes of burn may limit the depth of this type of burn and reduce pain.

Do not deliberately break blisters because this may lead to secondary infection.

If blisters do spontaneously rupture, allow the fluid to drain and treat the burn as outlined previously.

Third-degree burns and full-thickness second-degree burns

All full-thickness burns, regardless of size, should be referred to medical attention as soon as possible.

First aid treatment for burns (delayed medical treatment)

The attendant is often confronted with burns that are small but serious. If a place of medical treatment is close, these patients should be referred to a doctor.

When distance and transportation problems make it impossible for the patient to receive medical attention within two to three hours, these procedures should be followed

1. Cool the burn and assess the patient as outlined on page 193, the priority action approach to the Walk- In Patient.
2. Cover the burn with sterile gauze.
3. Clean the skin around the burn.
4. Remove the original gauze.
5. Clean burns gently with clean water or saline to remove foreign material. Tap water is satisfactory. Do not deliberately break blisters because this may lead to secondary infection.
6. Apply a topical burn preparation, if available. If a topical burn preparation is applied, the dressing must be changed daily.

7. Cover the burn area with several layers of sterile gauze. Moistened gauze may be used to help stop the gauze from sticking to the burn. Place a dry dressing or soaker over the moist gauze layer.
8. Hold the dressings in place with a conforming gauze bandage. The bandage must be snug enough to keep the dressing from falling off but not tight enough to break blisters or obstruct circulation.
9. Instruct the patient to keep their burned hands and/or feet elevated. A patient with burns to the feet should be treated in bed with the feet elevated. Do not splint burned extremities unless there is an obvious fracture or dislocation.
10. For minor burns that do not require medical attention, the dressing should be changed every 24 to 48 hours, or more often if the dressing becomes soiled or wet.
11. If a burn appears infected — usually after 12 to 24 hours or more — the patient must be seen by a physician.

Chemical burns

Chemical burns result from contact with corrosive or caustic substances, usually strong acids or alkalis.

A chemical will continue to burn as long as the substance remains in contact with the skin. Early removal of the chemical is of great importance.

The type of tissue injury varies with the chemical properties of the substance involved. The attendant should be familiar with the substances used in their particular workplace.

Three primary factors determine the severity of an injury:

- Properties of the chemical
- Concentration of the chemical
- Length of exposure to the chemical

Management of chemical burns

The management of chemical burns follows the priority action approach with special emphasis on the following considerations. Throughout the management, the attendant must be careful not to come into contact with the substance.

1. Immediately dilute and remove the chemical by copious flushing with water (see Figure 38-5). Speed is essential. Dry powder chemicals should be brushed from the skin before flushing is started, unless large quantities of water are immediately available (see Figure 38-6). For the specific management of hydrofluoric acid see page 305, Hydrofluoric Acid.
2. Begin flushing immediately, preferably with a hose or shower (see Figure 38-7) and flush vigorously with water for 30 consecutive minutes — by the clock. When the chemical is known not to be water soluble or the substance causing the burn is unknown and not dissolving in the water irrigation, mineral oil should be liberally applied to the burn site for one minute. Immediately following the mineral oil application, continue to flush with water for 30 minutes.
3. The use of buffer-irrigating solutions has been considered as an alternative to flushing with water for years. The purpose of the buffer or neutralizing agent is to neutralize the substance rendering chemicals harmless through chelation and encapsulation, eliminating or reducing the severity of the burn. The idea is logical, but impractical. Neutralizing agents are rarely as available as water and some create heat during the neutralizing process, harming the patient. Water irrigation is safe and practical. Immediate access to a flushing system is key in affecting outcomes.
4. Remove any of the patient's clothing that is soiled with the chemical. Continue flushing until the burning sensation stops.
5. Estimate the degree and extent of the burn using the rule of nines, as with a heat burn.
6. Continue flushing or use saline-soaked dressings, reapplied every 30 minutes, when possible.
7. Transport to medical aid, constantly monitoring and recording the patient's condition. It may be necessary to continue flushing the area during transportation.

Figure 38-5 Flush with water

Figure 38-6 Brush off dry chemicals before flushing

Figure 38-7 Use of a shower for flushing

Tar burns

Burns from molten tar require special consideration. Molten tar adheres to the skin and as long as it remains hot, it will continue to burn the patient. Therefore, the tar must be cooled as soon as possible with water. The affected part should be immersed in cool water for 10 to 15 minutes.

If the burned area exceeds 20% of the body surface, prolonged cooling should be avoided because it can cause hypothermia. Five to 10 minutes is sufficient. Once the tar is cool, it is not necessary to remove it from the skin immediately, unless the nose or mouth is obstructed and breathing is difficult. If the patient's trip to medical treatment is lengthy or delayed, mineral oil on gauze dressings may be applied and left on. The tar will gradually come off as it softens during the next 6 to 48 hours.

Electrical burns

Electrical contact with the skin and the body can produce devastating effects (see Figure 38-8 Electrical burn). The actual burn that the electrical contact produces may appear quite small. The major damage can occur inside the body, and the burn is often only visible as entrance and exit wounds. The internal tissues along the pathway of the current may be heated for a moment at 2500°C to 3000°C (4500°F to 5400°F) and, in effect, cooked. More information on electrical injuries is provided in the next chapter.

Figure 38-8 Electrical burn

Harmful effects of electrical burns

- Contact burns usually appear as entrance and exit burns, with the appearance of charred or grey, dry tissue. The extent of internal injury is difficult to assess.
- Flash burns are caused by an electrical flash and can appear as first- to third-degree surface burns.
- Thermal burns are caused by flame and can cause clothing to catch fire.
- Arcing burns occur when the current jumps from the current source to the worker or from one part of a body surface to another. Arcing can cause contact burns or ignition and burning of clothing.
- Alternating current may cause muscle spasms.
- Consequently, if the worker has grasped the current source it may be difficult to let go of it.

- The worker may be thrown, or fall, if working at a height (e.g., on a hydro pole). Associated fractures, internal injuries, and spinal injuries can occur.
- Electric shock may cause respiratory arrest and/or cardiac arrest (see page 284, True Electrical Injuries).

Management of the electrical burn patient

1. Conduct the scene assessment. Activate the workplace emergency response procedures as required. Ensure that the current is turned off and carefully remove the source of contact from the patient without endangering the rescuer.
2. Assess the level of consciousness. Attempt to communicate with the patient. If the patient is unresponsive and not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest. In this situation CPR/AED is initiated according to Part 5, Chapter 13.
3. When the patient is not in cardiac arrest, conduct the primary survey and perform critical interventions.
   A — Airways open, with C-spine control if necessary
   B — Breathing adequate
   C — Circulation assessed and bleeding controlled if necessary
4. Immediate assisted ventilation may be necessary. If a patient who has received an electric shock is conscious and breathing, reassure and keep them at rest.
5. Because these patients are in the rapid transport category, any burn or other injury management should be done en route to hospital and the patient monitored closely

Electrical injuries

This chapter introduces the attendant to the effects of electricity on the human body. By understanding how contact with electrical energy causes harm, the attendant will be able to assess and treat a patient who has experienced an electrical contact.

Electrical injury is a descriptive term for all trauma caused by contact with electrical energy. Such contact can cause a wide variety of possible injuries, involving most organ systems. The electrical charge may result from human activity or a natural cause (e.g., lightning) it may be high or low voltage, and it may be direct or alternating current.

One-quarter of all electrical injuries are work related. Approximately 3% of all burn admissions to hospital result from electrical injury.

Types of electrical injuries

Electrical injuries are classified in the following ways:

- Electrical flash burns
- Flame burns caused by the ignition of clothing
- True electrical injuries, which occur when an electrical current passes through the patient
- Lightning injuries

Electrical flash burns

Electrical flash burns are caused by heat released when an arc is formed between the electrical source and the ground. In this case, the arc does not pass through the body. The intense heat of the arc, several thousands of degrees, may cause first-degree through third-degree thermal burns to any part of the worker exposed to the arc. These burns should be managed the same as thermal burns, described on page 280, Major Burn Wound Management.

Flame burns

Flame burns caused by the ignition of clothing are common and are associated with high-voltage exposure — greater than 500 volts. These burns may also be first-degree through third-degree and are managed the same as thermal burns, described on page 280, Major Burn Wound Management.

True Electrical Injuries

The disorders that electrical injuries cause in the body are complex and poorly understood. The resistance of the skin varies with the moisture content. Therefore, skin damp with perspiration or oil will much more readily conduct electricity into the body. As the electric current travels through various tissues, it generates heat. This release of heat is what damages the tissues.

As the current passes into the body and out, it usually creates entrance and exit wounds. These wounds are often small, irregular, indented, and of a whitish-yellow hue (see Figure 38-8 Electrical burn). On occasion, their margins may be charred. The entrance and exit wounds may appear quite minor but extensive damage to nerves, blood vessels, muscles, and organs may have taken place as the current passed through the body.

The current always passes through some portion of the body as it seeks ground. In a typical hand-to-hand pathway, both the upper limbs and the organs of the thorax may be injured. As the heart is often affected, the incidence of death is highest with this route. In head-to-foot or head-to-hand pathways, the brain or spinal cord may be injured.

Skeletal muscle is especially vulnerable to repeated stimulation by alternating current. Profound muscle contractions may occur when a worker contacts an electrical current. The consequent muscle spasms may prevent a worker from releasing their grip, thus extending exposure to the current. Fractures and dislocations may occur as a consequence of these profound muscle contractions or may occur secondarily from falls.

Skeletal muscles, nerves, and blood vessels may be irreparably damaged in a high-tension, high-voltage wound. It is estimated that, as a result of these severe injuries, amputation has been necessary in up to 50% of cases. Early aggressive management of these patients in a burn centre can reduce further complications.

Damage to the heart is frequently seen in electrical injury. Even household alternating current frequently precipitates ventricular fibrillation — rapid ineffective contractions of the heart. Complete heart stop (cardiac arrest) is the major cardiac effect of a direct-current electrical injury. Cardiac arrest is fatal unless treatment is initiated immediately. An electrical current through the heart can also cause an irregular heartbeat or a heart attack, with all of its complications (see page 111, Heart Attack).

Damage to the nervous system is frequently seen. Mild electrical injury may cause anxiety, confusion, headache, dizziness, impaired memory, and/or difficulty concentrating. Much more serious electrical injury may cause respiratory or cardiac arrest due to direct brain-stem injury. Other effects include seizures, spinal-cord injury with paralysis, and permanent damage to peripheral nerves in the limbs. Eye injuries include immediate burns to the eyes, as well as the subsequent development of cataracts.

The abdomen and its contents may also receive serious injury, particularly if the electrical current travels through the torso. The patient may complain of abdominal pain, nausea, and vomiting. The abdomen may be tender, distended, or rigid. As with blunt trauma, injury to the abdominal organs is frequent.

Signs and symptoms of true electrical injury

The patient with an electrical injury may have any of the following signs or symptoms (see Figure 39-1 Possible findings in an electrical injury):

- Respiratory arrest, difficulty breathing, or a swollen tongue
- Cardiac arrest, an irregular heartbeat, or heart-related chest pain
- A decreased level of consciousness, paralysis, or seizures
- Restlessness, irritability, anxiety, or confusion
- Shock
- Visual difficulties
- Entrance and exit burns or associated thermal burns (flame burns) are caused by the ignition of clothing
- Fractures and/or dislocations from profound muscle spasm or an associated fall
- Abdominal pain, nausea, vomiting, or tender, distended, or rigid abdomen

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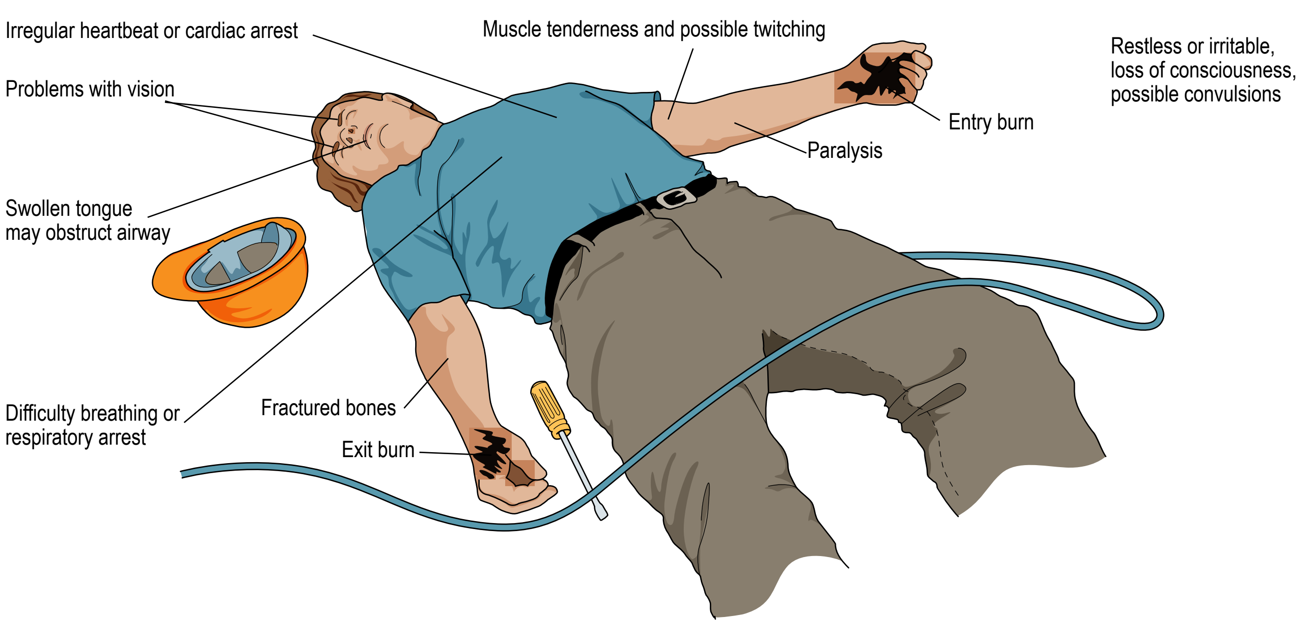


Figure 39-1 Possible findings in an electrical injury

Management of true electrical injuries

The evaluation and management of the injured worker with an electrical injury follows the priority action approach as outlined on page 18.

1. Conduct the scene assessment. Activate the workplace emergency response procedures as required. Extreme caution is urged when the attendant approaches the scene of a worker injured by electricity. Such locations are often very hazardous. If the electrical source is still active or the attendant is unsure whether it is, no attempt must be made to rescue the worker unless the attendant has been trained to do so and all the necessary personnel and equipment are available.The specific protocols for rescuing a worker at the site of an electrical incident are beyond the scope of this chapter. The attendant who works in an environment where there is a potential for electrical injuries should obtain appropriate training in those protocols.
2. Assess the level of consciousness. Attempt to communicate with the patient. If the patient is unresponsive and not breathing normally, or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest. In this situation CPR is initiated according to Part 5, Chapter 13.
3. When the patient is not in cardiac arrest, ensure there is an open airway with cervical spine control, if the mechanism of injury suggests spinal trauma.
4. Assess the patient's respiration and assist ventilation if needed according to the criteria on page 60. Administer oxygen at 10 L/min if necessary. If the patient is unresponsive to verbal stimuli, attempt to insert an oral airway.
5. Assess the patient's circulation by feeling for a radial pulse. If the radial pulse is not found, assess the carotid pulse. if the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest. In this situation CPR is initiated according to Part 5, Chapter 13.
6. Conduct a rapid body survey.
7. Any patient who has sustained a significant electrical injury, as evidenced by a decreased level of consciousness, the signs and symptoms of shock, a burn, or injury to the heart or abdomen is in the rapid transport category.
8. All workers who have suffered an electric shock injury must be referred to a physician when the history or assessments reveal any of the following:
   - inability to let go of the electrical source
   - injury to the nervous system, suggested by restlessness, irritability, anxiousness, confusion, or visual difficulties
   - injury due to a muscle spasm
   - contact with current above standard household current

Lightning

Lightning injuries are frequently mistaken for other conditions. They cause coma, confusion, and/or seizures. Often, a history of a thunderstorm or a witness to the lightning strike may be absent, especially if the worker was alone at the time of the strike.

The injury from a lightning strike is distinctly different from other high-voltage electrical incidents because the duration of the strike is so brief. Even though the average voltage may be 10 to 20 million volts, the duration of the current flow is so short that, often, little energy is delivered to the body. Consequently, the current does not have time to break down the skin or cause internal tissue damage. The lightning primarily splashes over the outside of the individual and does not cause significant burns or tissue damage. The major effects are cardiac and respiratory arrest. An over-activation of the sympathetic nerves to the vessels of the extremities may also occur. This causes diminished peripheral circulation, as evidenced by blue, mottled, cold, pulseless limbs. Other nervous system changes may occur, as previously described under electrical injuries. The attendant must carefully examine the patient to rule out injuries that may have been caused by blunt trauma associated with a fall at the time of the lightning strike.

Lightning-related deaths and injuries occur quite often. The most commonly affected groups of people are construction workers, campers, and outdoor enthusiasts.

Lightning strikes may involve more than one worker, as the ground current may spread throughout a small area where individuals are seeking shelter from the elements.

It is estimated that lightning strikes are fatal approximately 30% of the time. The major cause of death is cardiorespiratory arrest. The lightning delivers a massive direct current shock to the heart, causing it to stop. It also shocks the brain stem, causing an arrest of respiration. CPR/AED should be started immediately for patients who are unresponsive, are not breathing normally — or have only occasional gasps and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse. In the absence of cardiorespiratory arrest, patients are unlikely to die of any other cause.

Workers who have been struck by lightning are in the rapid transport category and should be managed as outlined for true electrical injuries on page 286.

Prevention of lightning injuries

- Stay low. Crouch down in an open field and lean forward, with your hands on your knees, so that contact with the ground is minimized. Avoid being on a hill or other area where you project above the surrounding landscape.
- Get away from open water.
- Stay away from objects that project above the ground — e.g., trees, poles, antennas.
- Stay away from electric conductors. Do not hold onto any tools or items that could serve as a lightning rod. Avoid chain-link fences, metal pipes, or other conductors from which lightning could reach you.

Bites and stings

Bites and stings are sometimes regarded as insignificant and can often cause minor swelling, redness, pain, and itching. These mild reactions are common and may last from a few hours to a few days. Some insects are more likely than others to cause allergic or toxic reactions and can, on occasion, very quickly become life-threatening.

This chapter introduces the attendant to the signs and symptoms of mild and severe allergic reactions and provides treatment recommendations for common bites and stings.

Insect bites

Bites may involve a local injection of poison into a wound with a generalized effect. They may also involve a local and systemic invasion of bacteria.

Bites should be managed like any other soft-tissue injury, with thorough cleansing, appropriate dressings, and referral to medical aid as necessary.

Stings

Wasps and bees are the most typical stinging insects. Stings may be managed at the first-aid level except when the patient exhibits a systemic allergic reaction to venom. In these cases, there may be considerable danger to the patient. Severe allergic reaction necessitates rapid transportation to a medical facility.

Stings inside the mouth or throat and multiple stings are potentially dangerous. They may cause constriction of the airways and a sudden loss of consciousness — coma. Such stings should be treated as a high-priority emergency.

Management of local reactions

Some stinging insects leave their stinger and poison sacs embedded in the skin. Using a sterile needle, the stinger should be removed under magnification, without squeezing the bag of venom.

The stinger and venom cause a local or generalized release of histamine. This substance does not normally circulate but causes localized redness, itchiness, and swelling. Commercially available antihistamines are useful for this condition. Strict attention must be paid to recommended dosages. Several antihistamine preparations cause drowsiness. This should be taken into consideration before the patient returns to work or operates a vehicle.

Most people stung by insects have a localized reaction. The local application of ice tends to limit swelling, but stings that occur in the mouth and throat should be treated as potential emergencies because of swelling in the upper airway.

The wound or local inflammation should be managed in much the same way as most soft-tissue injuries. For stings that are not in the mouth or eyes, after initial cleansing, application of a preparation containing an aluminum salt (e.g., Burow's Solution™, BuroSol™, or a roll-on antiperspirant) may provide relief from pain and swelling by deactivating the venom. This should be followed by application of an ice pack.

Allergic reaction

People who have an allergy to insect stings may carry a device known as an epinephrine auto-injector. If stung, these patients will inject themselves if they have an autoinjector available. The attendant should be ready to assist them if necessary. The attendant must ensure that the medication is not expired and the instructions provided with the epinephrine auto-injector are followed.

The symptoms of a systemic allergic reaction may include:

- Tightness of the throat or upper airway
- Breathing difficulty
- Weakness
- Generalized itching and redness of the skin
- Numbness and tingling
- Hives
- Anxiety
- Abdominal cramps, diarrhea, or vomiting

The patient may show signs of shock and may die if the reaction is extreme.

A severe allergic reaction is called anaphylaxis and it is life threatening. The patient's airway may close from swelling; the blood vessels dilate, which will lower blood pressure. This can progress to cardiac arrest very rapidly. Antihistamines are not effective and these patients require epinephrine add after epinephrine (adrenaline). Assist the patient with their epinephrine autoinjector and transport to hospital as soon as possible.

Management of allergic reaction

Management is supportive, with the attendant treating the symptoms present. The patient's condition should be assessed on the basis of their reaction to the sting, rather than the number of stings.

1. Maintain an open airway.
2. Maintain respiration, if necessary; assist ventilation using a pocket mask with oxygen.
3. Start CPR/AED if the patient is unresponsive and not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent, or the attendant is not sure whether the patient has a carotid pulse.
4. Patients undergoing a severe allergic reaction are in the rapid transport category. Rapid transport is essential, as these patients require drug therapy to counteract the allergic reaction.

Most people who know they have a serious allergy will carry an epinephrine auto-injector. This is a spring-loaded syringe that will administer a pre-measured dose of epinephrine to counteract the allergic (anaphylactic) reaction. In order to assist the patient, help them to hold the injector at a 90-degree angle to the skin and then press and hold firmly against the thigh muscle. Once the "click" is heard, hold the pen in place for a full 10 seconds. Massaging the area will aid in quicker dispersal. A second dose of epinephrine may be necessary.

An attendant may administer an epinephrine auto-injector to an unresponsive patient under the following circumstances:

- History of exposure to an allergen.
- The patient is showing signs of anaphylactic shock (see page 100).
- No known contraindications. The patient does not have a heart condition

Snakebites

About 20% of people bitten by poisonous snakes are not injected with venom.

A wide variety of home-remedy snakebite cures have been reported to be successful. Fortunately, most patients taking such remedies had not actually received venom. Home remedies are useless if there was any venom injected by the bite. All home remedies should be avoided.

Owing to greater vascularity, bites on the head and neck are more dangerous than those on the extremities.

Venom is a complex substance that varies greatly from snake to snake. For example, rattlesnake venom causes almost immediate tissue destruction. Blood and fluid leak into the tissues, causing marked swelling.

Bruising occurs rapidly and blisters may appear. The entire limb may swell in a matter of minutes. Pain is often excruciating.

Systemic signs of snake poisoning vary from minor to significant and may include:

- Development of shock
- Decreased respiration
- Vomiting, abdominal cramps, and diarrhea
- Fluid in the lungs (see page 77, Pulmonary Edema)

Identification of snakes

Poisonous snake

- The snake has eyes with slit-like or elliptical pupils.
- The mouth has two well-developed fangs hinged to the upper jaw.
- The rattlesnake has rattles on its tail.

Non-poisonous snake

- The snake has round pupils.
- The mouth does not have developed fangs, but small teeth arranged in rows.

Identification of snakebites

Poisonous

- One or two fang marks with typical puncture wound appearance.
- If venom is injected, there will be almost instantaneous excruciating pain, with associated swelling around the puncture wounds.

Non-poisonous

- Numerous tiny scratches
- Little local swelling
- Usually only slight discomfort and itching

General management of snakebites

It is imperative to get a patient bitten by a venomous snake to a medical facility as quickly as possible so specific antivenin treatment can be started. Such patients are in the rapid transport category. Conduct a secondary survey and administer treatment en route.

If possible, provide BCEHS or the receiving hospital's emergency department with advance notification of the type of snakebite so medical personnel can arrange to have the antivenin sent to the facility from a central depot.

Treatment

1. Lay the patient down and keep them quiet. Reassure the patient and keep them comfortably warm. Do not allow the patient to have any alcoholic beverages.
2. Immediately cleanse the wound with soap and water. Do not apply ice. The use of ice has been associated with an increased incidence of amputation. Cover the wound with sterile dressings.
3. Do not apply a tourniquet or restrictive bandage; it may increase the risk of local tissue destruction.
4. Do not excise the area or perform suction. Such measures have contributed to mutilated extremities.
5. Support the affected limb with a splint. Do not elevate the affected limb.
6. Follow the general principles of shock management (see page 101, The General Principles of Management of Shock).
7. If possible, the snake should be killed and taken to the hospital for identification. Be aware that the snake is most likely still in the area.

When working in an area where poisonous snakes may be encountered, the attendant should establish a protocol with the local hospital. The attendant should know if:

- Antivenin is available at that hospital
- The patient should be transported to another hospital if antivenin is not available
- A helicopter is available

Wood ticks

Ticks are found throughout forested areas and become a particular hazard during late spring through early summer (see Figure 40-1 Wood tick). Ticks burrow into the skin with their heads, then clamp on firmly with curved teeth, secreting a cement-like substance. A tick's attachment is so strong that its body is often pulled free from the head when removal is attempted.

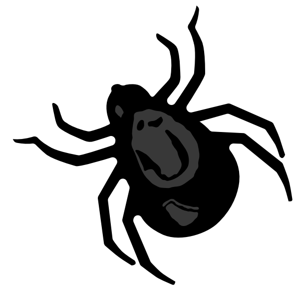


Figure 40-1 Wood tick

Ticks can transmit infectious diseases. Rocky Mountain spotted fever and Lyme disease are two of the most severe infectious diseases. Early medical treatment usually brings recovery. General symptoms may include:

- Headache
- Muscle and joint pains
- Fatigue or weakness of the muscles of the face
- Skin rash

Tick paralysis may develop from a tick's bite, especially if it occurs in the neck or spine area. The paralysis begins in the legs, then moves upward. Paralysis slowly improves on total removal of the tick.

It is important to remove a tick as soon as it is found. The longer an embedded tick remains, the greater the risk of paralysis. The aim is to extract the entire tick, including the head and mouth.

Wood tick removal

- Place a drinking straw or pen barrel down over the tick and slide a piece of thread down the straw so it is right next to the skin where the tick is attached (see Figure 40-2).
- Tie a firm (not too tight), single knot around the jaw
- of the tick as close as possible to the surface of the skin (see Figure 40-3).
- Remove the straw and pull the thread gently upward until the tick comes away from the skin (see Figure 40-4).
- An alternate method is to gently grasp the tick as close to the skin as possible using tweezers or forceps. Avoid squeezing the tick's body. Pull the tick out with gentle traction.

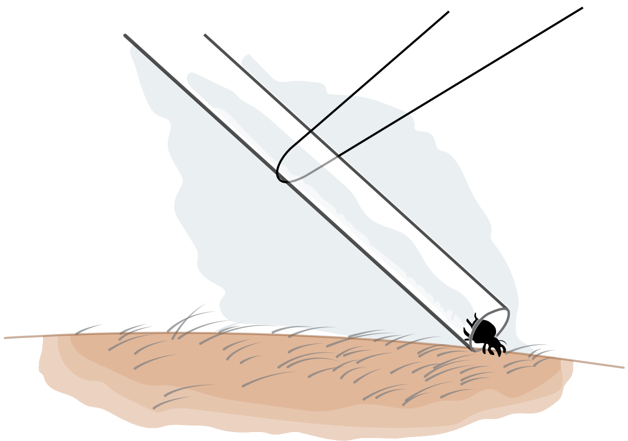


Figure 40-2 Slide thread down to skin level

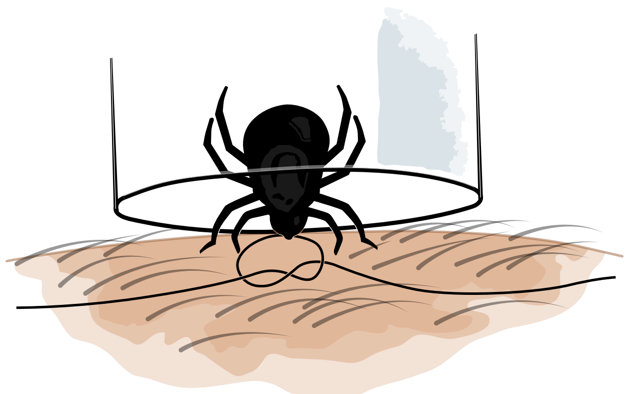


Figure 40-3 Tie firm knot next to skin

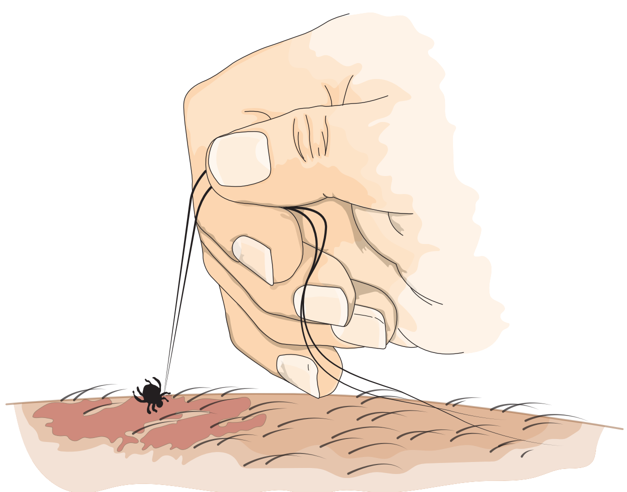


Figure 40-4 Pull thread upward

Do not apply heat such as a lit cigarette or match to the area. The danger of these methods is that the patient may be burned and the tick will usually die with the head remaining in the skin.

After removal, the area of the bite should be washed well with soap and water. The application of cold to the area may help reduce pain.

The patient should be sent to medical aid if:

- The body parts of the tick are separated from the head and the head cannot be removed
- The tick has been attached for more than 24 hours
- Signs or symptoms appear, such as paralysis, headaches, fever, or skin rash

Place the tick, alive if possible, in a small, sealed container with a moistened cotton ball and send it to medical aid along with the patient.

Animal and human bites

Because of bacterial contamination, there is a very serious risk of wound infection from animal or human bites. Owing to disease-producing organisms commonly found in the mouths of humans, these bites are usually the most serious (see page 313, Bloodborne Pathogens). Bites should be treated as a potentially infected major wound. They should be thoroughly cleansed, covered with a sterile dressing, and the patient referred to medical attention. More urgent medical attention may be required if the bite is considered to be contaminated with a bloodborne pathogen (see page 313, Bloodborne Pathogen Exposure).

If the patient has an animal bite, try to confine and isolate the animal and contact the closest public health unit.

Rabies

One of the more serious secondary complications of bites may be rabies.

In certain regions, rabies is still common. Rabies is a life-threatening viral illness transmitted by the bite of an infected animal. The possibility of rabies should be considered in the setting of a bite during an unprovoked attack from any animal, wild or domestic. The most common rabid bites are from foxes, bats, raccoons, and skunks.

Part 11, Chapter 41

Water and diving emergencies

Drowning is the process of experiencing respiratory impairment from submersion or immersion in liquid. The term *near-drowning* is no longer used. In 2005 the World Health Organization redefined the term. It's currently referred to as fatal and non-fatal drowning. Injury or death may result in hypothermia from immersion in cold water, sudden cardiac arrest due to immersion in severe cold water, spasm of the throat impairing respiration, or inhalation of liquid and subsequent impaired gas exchange.

Drowning

Signs and symptoms

The major signs and symptoms of drowning relate to the respiratory and nervous systems. The respiratory signs and symptoms vary in severity and may include:

- Absence of breathing
- Wheezing and dyspnea
- Rapid breathing
- Inability to take a deep breath
- Rasping cough
- Coughing up whitish or pink frothy sputum
- Substernal burning
- Cyanosis

Signs of nervous system impairment may include:

- Restlessness
- Lethargy
- A decreased level of consciousness

Management of non-fatal drowning patients

These patients require prompt and vigorous therapy. It is the same for both freshwater and saltwater patients.

If the patient is responsive but still in the water, a water rescue may be initiated. A swimming rescue is the least satisfactory method of rescue. Unless the attendant is an excellent swimmer and trained in lifesaving, they should not go into the water to rescue a patient. Many inexperienced individuals have been fatally drowned while attempting a swimming rescue of another individual. Even a good swimmer should wear a personal flotation device when using a boat or attempting a swimming rescue. A life preserver, rope, or any buoyant object should be thrown to the patient. The basic rule of water rescue is summarized in the lifesaver's motto: "throw, tow, row, and only then go." Although airway management and assisted ventilation should be initiated in the water (see Figure 41-1 Water rescue — possible spinal injury), effective CPR requires that the patient be out of the water. CPR has not been found to be effective in the water, even with the patient on a spine board.

The assessment and management of drowning patients follows the priority action approach outlined on page 18 and the general principles for the management of dyspnea as outlined on page 64.

1. Conduct the scene assessment. Activate the workplace emergency response procedures as required.
2. Perform a rapid, cautious rescue from the water while maintaining C-spine control. It is not uncommon to have spinal injuries with many water-related incidents. This is especially true if there is evidence of head injury. If details of the event are unavailable, the attendant must assume the person has a neck injury. Rescuers should remember that people who are struggling and drowning can be dangerous.
3. Assess the level of consciousness. Attempt to communicate with the patient. If the patient is unresponsive and not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest. In this situation CPR is initiated according to Part 5, Chapter 13. Procedures for clearing the airway of fluids may be necessary before compressions are given, (see page 60, Unresponsive Partial Airway Obstruction Due to Fluids).
4. Open the airway and remove any debris. Assist ventilation if needed according to the criteria on page 60. Elaborate lung-draining procedures waste valuable time, may induce vomiting, and are ineffective. If the patient is unresponsive to verbal

Figure 41-1 Water rescue — possible spinal injury

stimuli, attempt to insert an oral airway. If they are breathing adequately on their own, and spinal injury is not suspected, place the patient in a lateral position with the head positioned to allow gravity to drain fluids from the mouth and nose. If trained in the use of oxygen, apply oxygen.
5. Complete the primary survey.
6. Treat for hypothermia. Replace wet clothes with dry coverings if available.
7. The return of consciousness and of spontaneous respiration does not mean the patient is fully recovered. All drowning patients are in the rapid transport category.

Such patients must rest, even though they seem to have recovered. Delayed complications such as pulmonary edema are common with non-fatal drowning and complex medical procedures may still be required to save the person's life.

Effects of cold water

Recent studies have shown that a person may survive prolonged submersion in water when the water is colder than 21°C (70°F), especially if the person is very young. Successful resuscitations with no consequent disability have been reported in cases where an infant was submerged in extremely cold water (3°C) for up to 1 hour, however, these cases are unique and rare. Submerged adult patients in cold water do not have the same survival. Prolonged resuscitation of cold-water drowning adults is futile and these patients do not improve with warming. Standard CPR/AED protocols should be followed. Paediatric extreme cold water drownings should have prolonged resuscitations and transport for warming if available.

Survival under those conditions occurs as a result of a primitive human response called the dive reflex. This reflex can also be triggered when cold water suddenly hits a person's face. It shuts off the blood flow to most parts of the body, but not to the heart, lungs, and brain. The cold water temperature also reduces the metabolic rate of the body, reducing the need for oxygen. Whatever oxygen remains in the blood is made available to the brain, where it is needed most.

Diving emergencies

Diving incidents may cause a variety of complex medical problems. Immediate and proper attention must be given to the patient at the incident site, but the attendant must not delay transport to a hyperbaric facility — a facility where 100% oxygen can be administered at greater than normal atmospheric pressure. Prompt transport will help to minimize residual medical problems after treatment.

Anyone who may have to deal with a diving emergency (e.g., instructors, divers, dive supervisors, first aid attendants, and rescue personnel) must be able to recognize the signs and symptoms associated with pulmonary barotrauma injury due to pressure and decompression illness.

In diving and similar pressurized working environment incidents, treatment must be initiated immediately. Treatment includes:

- Recognition
- Maintenance of ABCs
- Administration of oxygen
- Arranging immediate evacuation to a hyperbaric facility

Pulmonary barotrauma

When a diver ascends in the water, air in their lungs expands. If there is any obstruction to air outflow from the lungs (e.g., due to pre-existing respiratory problems, breath-holding on ascent, rapid/uncontrolled ascent), gas trapping and pulmonary overpressure may occur with subsequent alveolar rupture. Pulmonary barotrauma may also cause pneumothorax, as well as mediastinal and subcutaneous emphysema. Lung barotrauma injuries may occur in as little as 1 m (3 ft.) of water, as pressure and volume changes are greatest near the surface.

Decompression illness

Decompression illness is the term currently used for both decompression sickness (DCS) and arterial gas embolism (AGE). The newer terminology is favoured because problems from exposure to elevated atmospheric pressure and decompression occur on a continuous, overlapping spectrum. Differentiation between AGE and neurological DCS is difficult and both may occur concurrently. The treatment for these conditions is the same.

Arterial gas embolism

With pulmonary barotrauma, air from ruptured alveoli may enter the blood circulation and cause AGE. This can cause blockage of blood vessels in any part of the body.

Decompression sickness (DCS)

DCS refers to cellular changes caused by excess inert gas bubbles in tissues and their biochemical interaction with elements of the blood. It can occur in any diver who does not follow acceptable dive tables, and/or disregards safe diving practices when diving deeper than 8 m (25 ft.). Some other risk factors for DCS include strenuous exercise, cold, age, obesity, dehydration, alcohol, repetitive diving, and flying in a plane after diving. Even when following accepted dive tables, an individual may still develop DCS.

Signs and symptoms of decompression illness

Decompression illness may involve one or more of the following symptoms occurring at different times. The symptoms may develop during a dive, up to 24 hours after a dive, or even later. These signs and symptoms can involve virtually any organ system, especially the central nervous system, and include:

- Pain in the limbs, joints, or abdomen
- Headache
- Nausea or vomiting
- Fatigue
- Muscle weakness or twitching
- Numbness, tingling, and sensory changes
- Bowel or bladder problems
- Loss of balance or coordination, staggering
- Visual changes
- Hearing or speech difficulties
- Shortness of breath
- Chest pain
- Cough or hemoptysis
- Pink frothy sputum
- Cyanosis
- Dizziness or faintness
- Irritability or personality change
- Confusion or disorientation
- Convulsions
- Shock
- A decreased level of consciousness

Management of pulmonary barotrauma and decompression illness

1. Conduct the scene assessment. Activate the workplace emergency response procedures as required.
2. Assess the level of consciousness. Attempt to communicate with the patient.
3. If the patient is unresponsive and not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest. In this situation CPR/AED is initiated.
4. When the patient has any response, ensure an open airway, assess respirations, and assist ventilation if needed according to the criteria on page 60. Provide oxygen, ideally at a concentration of 100%. Oxygen should be administered during the entire time required to transport the patient to a hyperbaric chamber.
5. Complete the primary survey.
6. All patients suffering from possible pulmonary barotrauma or decompression illness, no matter how mild the condition, require emergency diving medical assessment and are in the rapid transport category. Take the patient to the closest hospital where they can be stabilized and arrangements for transfer to a hyperbaric unit can be made — very few hospitals have a hyperbaric chamber. They must be transported to the facility by stretcher and the patient must do as little activity as possible. If patients are to be transported by air, the aircraft should be pressurized to one atmosphere (ATA), if possible. Alternatively, a helicopter should fly at less than 2,000 ft. altitude or, ideally, if safe and possible to do so, at less than 1,000 ft.
7. Contact the nearest hyperbaric facility and state that there is a diving medical emergency — in British Columbia, contact Vancouver General Hospital at 604.875.4111.

Conscious diver

1. Position the patient supine, conduct a primary survey and any interventions.
2. Deliver high concentrations of oxygen — e.g., using a non-rebreathing mask and oxygen at 10 L/min or at 15 L/min if needed to keep the reservoir inflated.
3. The patient who is able to do so, without compromising the airway, may take oral fluids such as water or diluted juice. Do not give the patient caffeine or alcohol.
4. Transport the patient by stretcher.

Diver with a decreased level of consciousness — normal breathing present

1. Position the patient lateral or supine for airway management.
2. If the patient is unresponsive to verbal stimuli, insert an oral airway.
3. Deliver high concentrations of oxygen — e.g., using a non-rebreathing mask and oxygen at 10 L/min or 15 L/min if needed to keep the reservoir inflated.
4. Assist ventilation if needed according to the criteria on page 60.

Diver with a decreased level of consciousness — breathing absent

1. Position the patient supine.
2. Open the airway and assess for breathing and a carotid pulse for 5-10 seconds, 30 seconds if the patient is hypothermic.
3. If the patient is unresponsive and not breathing normally or agonal breathing is seen (sporadic gasping breaths), and the carotid pulse is absent or the attendant is not sure whether the patient has a carotid pulse, it should be assumed that the patient is in cardiac arrest. In this situation CPR/AED is initiated according to Part 5, Chapter 13.
4. When the patient is not in cardiac arrest, insert an oral airway and assist ventilation if needed according to the criteria on page 60.
5. Apply high flow oxygen.

Critical points of field care for an injured diver:

- The attendant must recognize possible problems based on the history and the patient's signs and symptoms. In B.C., occupational divers are required to wear medical alert tags or bracelets, stating their status and indicating the possibility of a diving-related illness, for at least 24 hours after completion of diving.
- The attendant must begin non-stop delivery of the highest possible concentration of oxygen (ideally 100%) to be continued even if the symptoms seem to pass. Oxygen is an imperative part of the field and medical treatment of diving injuries. When the patient inhales the oxygen, the oxygen tension helps to rid the blood of inert gas bubbles. The elevated oxygen tension also allows better oxygenation of tissues where the blood supply has been impaired by bubbles.
- Regardless of how minor the patient's symptoms may seem, it is imperative that the diver not go back into the water to attempt treatment or to complete omitted decompression stops.
- The attendant must constantly monitor the patient for changes in condition and note whether or not the patient is able to empty their bladder. If so, the volume of urine passed should be recorded.
- The attendant must gather and record, in writing, an accurate dive profile history for the hyperbaric chamber physician.

Emergency evacuation

If the patient is a diving incident patient and someone is caring for their immediate medical needs, someone else must be arranging for transportation to a hyperbaric facility. It is necessary to know how to contact assistance from sea or land.

Procedures must be in place to ensure that, as a result of making contact with either the BCEHS ambulance service, a Coast Guard radio station, or a Rescue Coordination Centre (RCC), an injured diver will be transported, under care, to a hyperbaric facility.

Communications

- From land, for help that is accessible by land, contact the BCEHS ambulance service (call 911) and indicate there is a diving emergency. Be prepared to provide the following information:
  - Your name and phone number.
  - Your exact location, GPS coordinates if available, and any other specific information that will help the BCEHS ambulance crew locate you quickly.
  - The patient's condition in detail. Be prepared to
  - provide an immediate update of the patient's vital signs.
- From a boat, contact the Coast Guard radio station, channel 16 marine VHF. Declare an emergency and say, "This is a diving emergency." Be prepared to respond with the following information
  - Your exact location, by marine chart and GPS coordinates if available

  - A description of your vessel and status — in danger or not in danger
  - The patient's condition in detail
- From an isolated location — away from populated centres — contact the Rescue Coordination Centre. Declare an emergency and say, "This is a diving emergency". Be prepared to respond with the following information:
  - Your name and phone number or frequency
  - Your exact location and GPS coordinates if available, and any information that will help the Rescue Coordination Centre to direct a rescue resource to you
  - The patient's condition in detail

Evacuation preparation

- Oxygen delivery must never be discontinued.
- All diving-incident patients are stretcher-transport patients.
- Ensure that the patient is kept warm — treat for shock and hypothermia.
- Ensure that all responding rescue and ambulance resources understand that this is a diving incident.
- A complete patient history, in writing, should accompany the patient. Describe the events leading up to the incident and treatment actions after the incident. If possible, send the diving buddy with the patient.

If the evacuation is being conducted from a boat at sea by helicopter:

- Try to establish communications with the helicopter
- to receive their specific directions.
- If communications with the helicopter are not possible:
  - Secure all loose objects on and around the decks
  - Put all antennas and other movable structures down if they will interfere with the evacuation
- When the helicopter is on the scene:
  - Maintain a course into the wind approximately 20 degrees off the bow.
  - Maintain a constant speed of 10 to 15 knots. Do not slow down or speed up in an effort to help.
  - Allow the lifting device from the helicopter to touch the deck before you touch it and do not tie it to your vessel.
  - Ensure that your patient is secured in the stretcher/lifting device.
  - Ensure that all written information is sent with the patient.

Part 12

Poisonings

Part 12: Poisonings

Poisons

A poison is any substance that harms the human body, damaging health or destroying life. attendants must know how to deal with exposure to hazardous materials and poisonings in the work environment. They must acquaint themselves with all hazardous materials and poisons used at their workplaces and the appropriate first aid treatment for each. Employers must comply with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS, also known as WHMIS) regulations and other applicable occupational health and safety regulations. These regulations require that information about hazards and toxicity be available to workers who may be exposed to hazardous materials in the workplace. The safety data sheet (SDS) for each hazardous material also contains first aid information vital to the attendant. If the information is not available, the attendant should ask their employer to obtain it through the manufacturer or supplier.

First aid attendants should have written procedures for dealing with all poisons and dangerous substances used at their workplace. The SDS is the best source of information about appropriate procedures for each substance.

The local Poison Control Centre should also be contacted for treatment details. For poisoning questions or emergencies, call the BC Drug and Poison Information Centre at 604.682.5050 or 1.800.567.8911 (24-hour line).

Classification of poisons

All poisons can be classified into three general categories by route of exposure.

1. Poisons that are absorbed by inhalation (substances, including gases, that are breathed in)
2. Poisons that are ingested (substances that are swallowed)
3. Poisons that affect the body through direct contact (substances that come into contact with any body surface — e.g., skin, eye, mouth, or other mucous membranes)

General mechanism of injury

Inhaled poisons

Inhaled poisons can cause injury in three main ways

- Reduction of the oxygen-carrying capacity of the blood, thereby causing tissue hypoxia (e.g., carbon monoxide poisoning)
- Direct irritation of the lung tissues, which impairs oxygenation of the blood (e.g., chlorine gas)
- A direct toxic effect on cells (e.g., hydrogen sulfide affects brain cells)

Ingested poisons

Ingested poisons affect the body by destroying the tissues of the digestive tract or by being absorbed into the body and causing adverse health effects. Accidental poisoning by ingestion is usually caused by drugs, chemicals, or bacterial toxins.

Skin-contact poisons

Some substances may cause skin destruction or irritation on contact — a chemical burn. Other substances (e.g., pesticides) may be absorbed and cause adverse health effects when in contact with the skin, eyes, or mucous membranes. Some substances can both burn and be absorbed (e.g., cyanide and phenols).

Priority action approach for poisoning

All patients with suspected poisoning should be initially assessed and treated using the priority action approach (see page 18).

1. Conduct the scene assessment:
   - Make sure there is no danger. Wear protective equipment if the area is contaminated. This may have to be worn until any chemical is removed from the patient.
   - The patient should be moved to a safe area before you initiate your treatment. Do not risk exposing yourself to injury, or the patient to further injury.
2. Conduct a primary survey and perform critical interventions.
   - The primary survey should not take longer than two minutes. By this time, the attendant should also have noted the patient's level of consciousness. Based on the nature of the exposure, the results of the primary survey, and the level of consciousness, the attendant can now determine if the patient is in the rapid transport category.

If the patient is not initially in the rapid transport category, transfer to hospital may still be required. With the exposure to certain hazardous materials, the onset of toxic effects may be delayed. Although the patient may initially appear stable, they may deteriorate some time later. Reassess the patient often.

In addition, it is extremely important to identify the suspected poison. After completing the primary survey and preparing the patient for rapid transport as required, the attendant should always contact the Poison Control Centre. Poison Control may advise that additional specific treatment is required — e.g., give diluent or initiate rapid transport protocol because of the seriousness of the poisoning. Remember to record the name and the concentration of the suspected poisons and send this to the hospital with the patient. If feasible, send the labelled container and the SDS.

Poisoning by inhalation

This section describes immediate management of the patient who has inhaled poison and gives an overview of four poisonous gases.

Inhaled poison management

Oxygen therapy should be given as soon as possible to anyone who may have inhaled a toxic substance.

Assist respiration using a pocket mask with oxygen if required according to the criteria on page 60. Provided the patient has been moved to a safe environment, assisted ventilation will not usually pose any health risk to the attendant.

If assisted ventilation is not required, oxygen should be administered through an oxygen mask with reservoir at 10 L/min.

Keep the patient warm and at complete rest to keep the body's demand for oxygen at a minimum. Any increase in oxygen demand may cause further hypoxia and compound the toxic effects of the gas throughout the body.

A patient who is in the rapid transport category must be transported immediately to medical aid. Constantly monitor vital signs en route to hospital.

Carbon monoxide

Carbon monoxide is especially difficult to detect, being tasteless, colourless, non-irritating, and odourless. The hemoglobin in red blood cells combines chemically with carbon monoxide with an affinity of about 250 times greater than that of oxygen. For this reason, even a small percentage of carbon monoxide in the inspired air will quickly be taken up by the body's hemoglobin. If enough red blood cells absorb carbon monoxide instead of oxygen, the number of red blood cells available to carry oxygen will be inadequate. This causes oxygen starvation to the tissues (hypoxia). In addition, carbon monoxide prevents cells from utilizing oxygen, adding to the oxygen starvation. People who have suffered smoke inhalation often have carbon monoxide poisoning as well as poisoning from other toxic gases.

Signs and symptoms

Not all patients have every sign and symptom, so it is very important that the attendant take a history.

The following signs and symptoms are possible with carbon monoxide poisoning:

- Headache
- Dizziness
- Confusion — may appear drunk
- Nausea and/or vomiting
- Drowsiness
- Rapid pulse
- Dilated pupils
- Rapid respiration
- Convulsions
- Decreased level of consciousness
- Death

Management

The assessment and management of patients who have inhaled carbon monoxide should follow the Priority Action Approach for Poisoning (see page 301).

The critical factor in the management of carbon monoxide poisoning is the speed at which the carbon monoxide is removed from the body. High-flow oxygen, at the highest concentration available (100% oxygen is preferred) must be provided to speed the elimination of carbon monoxide.

For serious carbon monoxide poisoning where the patient has a decreased level of consciousness, medical management may necessitate treatment in a hyperbaric unit. The receiving physician should be notified that they are receiving a patient with possible carbon monoxide poisoning.

Chlorine gas

Chlorine gas has a pungent and disagreeable odour. In large concentrations, it may appear as a greenish-yellow cloud. It is heavier than ambient air and will collect in low-lying areas. Chlorine gas is a respiratory tract irritant. Irritant gases cause inflammation of lung tissues, which in turn may cause fluid to accumulate there. The walls of the alveoli thicken, interfering with the passage of oxygen from the alveoli to the blood, resulting in hypoxia. This inflammatory response to the irritant (pulmonary edema) takes time to develop.

Never underestimate the seriousness of chlorine gas poisoning, because the patient may have little discomfort at first. Even a few breaths of high-concentration chlorine gas may ultimately cause death.

Signs and symptoms

The following signs and symptoms are possible with poisoning by chlorine gas and other irritant gases:

- Eye and nose irritation
- Excessive tearing
- Respiratory distress/dyspnea
- Coughing
- Pain and burning in the throat
- Pain and/or discomfort in the chest
- Frothy, whitish, or pink-tinged sputum
- Nausea and/or vomiting
- Cyanosis
- Collapse
- Death

Management

The assessment and management of patients who have inhaled chlorine gas should follow the priority action approach for Poisoning (see page 301).

The crucial point in management is to extricate the patient from further exposure without endangering yourself.

Hydrogen sulphide

A colourless gas with an odour of rotten eggs, hydrogen sulfide (H_2S) is also heavier than air and collects near the ground. Because hydrogen sulfide impairs the sense of smell, an exposed worker may stay in a toxic area without being aware of continuing dangers. Hydrogen sulfide enters the body by inhalation and can be very dangerous even in small concentrations. It blocks oxygen use by the cells and has a direct toxic effect on the respiratory centre of the brain, causing a person to stop breathing.

Hydrogen sulfide is a by-product of many industrial processes. It may be explosive when mixed with air. It will burn and give off sulphur dioxide, which is irritating to the eyes and lungs.

Signs and symptoms

The signs and symptoms of a person exposed to hydrogen sulfide vary according to the concentration breathed. The indications of moderate and severe intoxication are as follows:

- Moderate intoxication:
  - Burning sensation of eyes and/or throat
  - Excessive tearing
  - Loss of sense of smell
  - Impaired judgment
  - Loss of balance
- Severe intoxication:
  - Decreased level of consciousness
  - Collapse
  - Respiratory arrest
  - Cardiac arrest

Management

The assessment and management of patients who have inhaled hydrogen sulfide should follow the priority action approach for Poisoning (see page 301).

The crucial point in management is to extricate the patient from further exposure without endangering yourself.

Cyanide

Hydrogen cyanide is a colourless gas that has a slight smell of bitter almonds. Not everyone, however, can detect this odour. Cyanide is highly poisonous by inhalation, skin contact, or ingestion. By a direct toxic effect, cyanide blocks oxygen use by all cells, often resulting in immediate death. Cyanide compounds are widely used as milling reagents and can be generated when any acidic material comes into contact with sodium or potassium cyanide.

Signs and symptoms

Large doses of cyanide can kill the patient almost instantaneously. With smaller doses of cyanide, the signs and symptoms can range from mild to severe, depending upon the cyanide's concentration and the worker's length of exposure. The following signs and symptoms are a guide only, as not all patients will have all of them:

- Breath smelling of bitter almonds
- Weakness
- Respiratory distress or respiratory arrest
- Shock
- Decreased level of consciousness
- Cardiac arrest

Management

The assessment and management of patients who have been poisoned by cyanide should follow the priority action approach for Poisoning (see page 301). The patient who has been poisoned by cyanide inhalation or ingestion is in danger of developing any of the symptoms listed in the previous section. Contaminated clothing that could further affect the patient or those providing care should be removed if possible. These patients will usually be in the rapid transport category.

Some workplaces that use cyanide compounds may have a Cyanokit® on site. This kit contains hydroxocobalamin, which is an antidote to cyanide. It must be given intravenously by a physician or someone who has been trained to start an intravenous line and give the antidote. This treatment will be limited to those sites where the attendant is licensed to perform such protocols.

Poisoning by ingestion

In industry, poisoning by ingestion is unusual but can occur nonetheless. Several disease conditions can cause the same signs and symptoms as poisoning, such as cerebral hemorrhage, epilepsy, hypoglycemia, and hyperglycemia. Some gastrointestinal conditions, such as acute indigestion or a peptic ulcer, may appear similar to lead poisoning. The attendant must specifically ask the patient about possible poisoning — e.g., what, when, how.

Ingested poison management

The assessment and management of patients who have ingested a poison should follow the priority action approach for Poisoning (see page 301).

If any of the ABCs are not properly cared for, all other treatment is pointless.

The assessment of the patient with suspected accidental poisoning should include:

1. Assess the vital signs
2. Obtain a history
3. Conduct a head-to-toe examination
4. Provide treatment

Vital signs

Assess and record the patient's vital signs as outlined on page 34, Vital Signs.

History

Identify the poison by chemical name and brand name if possible. Refer to first aid room files, SDS, or container labels as necessary.

- Ask the patient about possible poisoning. What? When? How? Record the details.
- Ask the patient about any nausea, vomiting, and/or diarrhea. Check for the presence of abdominal pain.
- Identify the ingested poison.
- Keep a sample of the poison and the container or label if possible. Send it with the patient to the hospital if medical assessment is required.
- Refer to the SDS.
- Phone the Poison Control Centre. If advised to do so by Poison Control, make immediate arrangements for transport of the patient to the nearest hospital

Head-to-toe examination

The physical examination should follow the guidelines covered on page 40, Head-to-Toe Examination. However, the attendant should specifically conduct the following assessments:

- Look for burns in and around the mouth.
- Smell the breath for any unusual odours. Note any unusual odours in the immediate area and on or about the patient.
- Ask the patient if they are having difficulty
- breathing or has a cough, and look for any signs of respiratory distress.
- Evaluate the patient for any signs of a decreased
- level of consciousness.
- Examine the skin of the extremities and trunk for rashes, lesions, or burns.

Treatment of a conscious and breathing patient

- Corrosive ingestion — acids and alkalis:
  - Do not make the patient vomit
  - Do not neutralize
  - Dilute immediately by giving the patient one to two glasses of milk or water
- Non-corrosive or hydrocarbon ingestion (i.e., petroleum products). If the poison is not a corrosive substance, Poison Control may instruct you to do the following:
  - Provide activated charcoal if the patient has stopped vomiting — the dose would be 50 gm (2 oz.) diluted in 250 ml (8 oz.) of water or juice.

- Provide activated charcoal if the patient has stopped vomiting. The dose would be 50 g (2 oz.) diluted in 250 mL (8 oz.) of water or juice.
- The Poison Control Centre may instruct you to use activated charcoal immediately. Do not administer activated charcoal to a patient who cannot swallow due to a decreased level of consciousness.

Patients who have ingested a hydrocarbon must be watched closely while they are vomiting to ensure that no aspiration occurs. A very serious pneumonia may result if hydrocarbon enters the lungs.

Do not make the patient vomit if any of the following conditions exist:

- The patient is too drowsy to sit up, has a decreased
- level of consciousness, or is convulsing.
- The patient has ingested corrosive acids or alkalis.
- The Poison Control Centre has not been consulted.

Poisoning by skin contact

It is essential to decontaminate the skin as soon as possible after contact, because as long as the skin is contaminated, some effects may continue. Prolonged contact can result in damage to the skin itself or toxic effects from absorption of the material through the skin. Often the person is unaware that skin contact has occurred.

Substances that can directly affect the skin or be readily absorbed through it include some insecticides, solvents, cyanides, and heavy metals such as mercury.

Contact Poison Management

The assessment and management of patients who have contacted a poison should follow the priority action approach for Poisoning (see page 301).

Once the ABCs have been assessed and managed, proceed as follows:

1. If the chemical is dry, brush it off before flushing the skin (see Figure 42-1).
2. Wash off the skin immediately with large amounts of water (see Figures 42-2 Flush with water).
3. Remove contaminated clothing.
4. Take precautions to avoid contamination to yourself and further contamination of the patient.
5. Treat all burned areas as for a dry burn.
6. Transport the patient to medical aid.

Do not neutralize corrosive poisons with acids or alkalis; instead, flush with lots of water and continue flushing en route to medical aid if possible.

Figure 42-1 Brush off dry chemicals before flushing

Management of chemical burns

See page 166, Management of Chemical Burns to the Eye, and page 281, Chemical Burns.

Hydrofluoric Acid

Hydrofluoric acid (HF) is an extremely corrosive chemical and one of the strongest inorganic acids. The devastating effects of hydrofluoric acid cannot be overemphasized. Advance planning with a clear, concise treatment procedure must be readily available wherever this chemical is in use.

Signs and symptoms of skin contact

- With solutions of less than a 30% concentration of hydrofluoric acid, pain may not be felt for up to 24 hours.
- Solutions of a concentration greater than 30% will usually produce immediate pain, which may be excruciating regardless of the depth of the burn.
- Hydrofluoric acid causes severe burns and slow-healing skin ulcers, and may result in loss of fingernails and toenails.

Signs and symptoms of inhalation

- Inhalation of hydrofluoric acid can cause chemical pneumonitis and/or pulmonary edema.

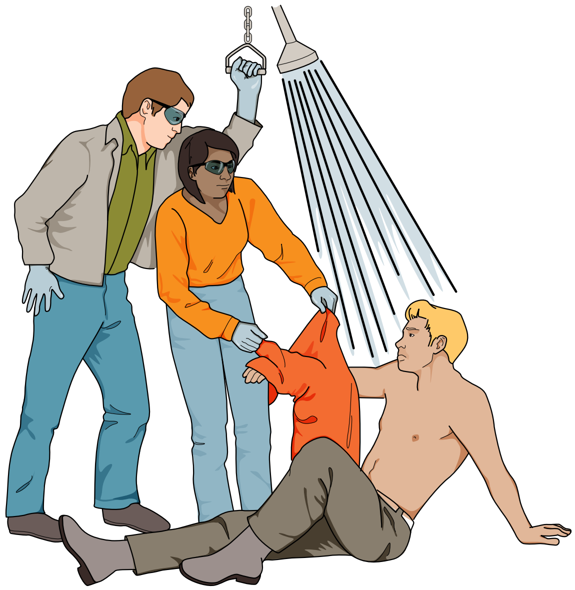


Figure 42-2 Flush with water

Management

Any workplace where the potential for hydrofluoric-acid injury exists should have a supply of HF antidote gel (calcium gluconate) on-site. Use the neoprene gloves and manage the patient as follows:

1. Manage the patient's ABCs. If the exposure has been to the skin, immediately flush it with copious amounts of running water for one minute.
2. Massage HF antidote gel onto the affected area until pain ceases.
3. If the gel is not available, soak the affected area with an iced solution of 25% magnesium sulphate (Epsom salts) zephiran 0.13%, or iced water.
4. For hydrofluoric acid in the eyes, treat as for chemical burns to the eye (see page 166, Management of Chemical Burns to the Eye).
5. If hydrofluoric acid is inhaled, the treatment is the same as for chlorine gas (see page 302, Inhaled Poison Management).
6. A patient with hydrofluoric acid poisoning is in the rapid transport category. Transport the patient while continuing the treatment stated above.

Substance abuse

According to the World Health Organization, substance abuse refers to the harmful or hazardous use of psychoactive substances, including alcohol and illicit drugs. Substance abuse is becoming more prevalent in society and in the workplace. A large number of work-related injuries are due to substance abuse. Persons under the influence of any psychoactive substance pose a hazard to themselves as well as their co-workers. Therefore, an attendant should be aware of the problems associated with substance abuse.

Any substance can be abused or misused. All drugs, legal or illegal, prescription or non-prescription, have the potential to be abused or misused. It is not uncommon for several drugs and substances to be abused simultaneously. This section discusses the most commonly encountered psychoactive (mind-altering) substances.

Types of abused substances

Commonly abused substances may be divided into three major groups: depressants, stimulants, and hallucinogens.

Central Nervous System Depressants

Common depressants are alcohol, narcotics, barbiturates, tranquilizers, and cannabis.

Alcohol

Alcohol is a commonly abused depressant. As it is estimated that 5% of the population is alcohol dependent, it is possible that the attendant will encounter alcohol-intoxicated patients in the workplace.

Signs and symptoms:

- Alcohol on the breath
- Inappropriate behaviour
- Bloodshot eyes
- Loss of coordination
- Slurred speech

If excess alcohol has been consumed, the patient may become difficult to rouse. The attendant must not assume that an unresponsive patient is necessarily intoxicated. The attendant must be careful not to overlook serious injuries or illnesses in the intoxicated patient. Diabetic coma, serious head injuries, sepsis, or other illnesses may be overlooked if patients are considered to be "just drunk."

Narcotics

Narcotics are opiates and include opium and its derivatives: morphine, heroin, codeine, fentanyl, Talwin™, Darvon™, and other drugs.

Signs and symptoms:

- Pinpoint pupils
- Shallow, slow, or absent respiration
- Impaired coordination
- Decreased level of consciousness
- Ultimately, death from respiratory arrest

Barbiturates and tranquilizers

Signs and symptoms of intoxication with barbiturates and tranquilizers are similar to those of alcohol intoxication, with drowsiness being the predominant symptom.

Central nervous system stimulants

Common stimulants are cocaine and amphetamines.

Cocaine

Cocaine is an alkaloid extracted from the leaves of the tropical coca plant. It has two effects: central nervous system stimulation and a local anaesthetic action. Cocaine is usually available as a white crystalline powder that is inhaled (snorted) and is absorbed by the nasal mucosa. It can also be dissolved and then injected intravenously. Additionally, it can be modified into other forms, which are inhaled by smoking and absorbed by the lungs.

These are:

- Crack — rock-like chunks of processed cocaine
- Freebase — a purified form of cocaine made by applying solvents to ordinary cocaine
- Coca paste — a crude coca preparation, usually smoked on tobacco cigarettes

Cocaine can cause the following medical emergencies:

- Cardiac irregularities — Even in small doses, cocaine can cause a heart attack and cardiac arrest in an otherwise healthy user with no history of heart disease.
- Stroke — A cocaine-triggered rise in blood pressure can rupture weakened blood vessels in the brain.
- Overdose — A cocaine overdose can produce seizures, coma, respiratory difficulties, and/or cardiac arrest.

Common signs of cocaine use are:

- Stimulated mental state ranging from exuberance to anxiety to paranoid psychosis
- Rapid pulse

Amphetamines

These drugs have a variety of uses, including offsetting drowsiness and fatigue, suppressing the appetite, and acting as a decongestant.

The primary effect of amphetamines is hyperstimulation, which is similar to the effect of cocaine. With chronic use, hallucinations may be present. Overdose with amphetamines may have the same effect as cocaine overdose.

Hallucinogens

The common drugs in this group are LSD, mescaline, magic mushrooms, MDA, STP, and PCP (angel dust).

The major effect of these drugs is to cause hallucinations. Users may exhibit behavioural changes such as aggressiveness, paranoia, and anxiety. Users can be dangerous to themselves and others and should be watched closely.

First aid attendant's responsibility

The attendant's main responsibility in cases of substance abuse is to maintain life support while obtaining medical help. The attendant should be aware that alcohol and drugs may be involved where injuries occur in the workplace. The interpretation of the signs and symptoms may be difficult because of the effects of these substances on the sick or injured worker.

The attendant may encounter an injured worker where substance abuse has played a significant role.

The intention of this section is not to train the attendant how to deal with the general problem of substance abuse, but to heighten the attendant's awareness of the possibility of substance abuse when confronted with an injured worker.

A person must not enter or remain at any workplace if their behaviour or ability to work is affected by a substance so as to endanger themself, or anyone else. If a worker with a substance abuse problem approaches the attendant for help in this general area, or if first aid services are sought because a worker is under the influence of alcohol or drugs at the workplace, the attendant must provide necessary treatment to maintain the safety of the individual as well as the safety of others.

The worker should be referred to their family physician or employee assistance program. A number of support agencies are available to assist in the management of a substance-abuse problem and the attendant should not hesitate to refer patients to them.

The use of an opioid antagonist such as Naloxone (Narcan®) for treatment of a suspected opioid overdose is within the scope of services that an attendant may provide. The procedures to be followed for the administration of intramuscular Naloxone are similar to the procedures for the administration of intramuscular epinephrine. The procedures for the administration of both prescription and non-prescription medications are outlined on page 199. Page 289 includes the procedure for the administration of epinephrine, including administration for the unresponsive patient.

In the case of an unresponsive worker who may require Naloxone — the procedures follow the priority action approach. The attendant should focus on resuscitation and ventilation, until medical care can be accessed. If Naloxone is available, it may be administered at an appropriate time by the attendant.

Part 13

Communicable Diseases

Communicable diseases

A communicable disease (also called contagious or infectious disease) is an illness caused by the invasion of a host by organisms such as bacteria, viruses, fungi, and parasites. These diseases are contagious (transmissible from one person to another) and can be spread by a variety of mechanisms.

Routes of transmission

Communicable disease may be transmitted either directly or indirectly.

- Direct transmission:
  - Direct contact (touch)
  - Direct projection (directly coughing or sneezing on someone)
  - Transplacental (from mother to fetus)
- Indirect transmission:
  - Airborne (infectious droplets in the air)
  - Vehicle borne (carried by food, water, or objects)
  - Vector borne (carried by insects)

Types of infectious organisms

Infectious organisms include:

- Bacteria — microscopic single-cell organisms capable of self-replication (reproduction) — e.g., staphylococcus, tetanus, gonorrhea
- Viruses — small organisms that require the presence of host tissue to replicate — e.g., influenza, human immunodeficiency virus, viral hepatitis, herpes
- Parasites — plants or animals that live on or in another living organism (host) and derive a benefit at the expense of the host — e.g., giardia, tapeworms, lice
- Fungi — simple cellular structures with infectious properties — e.g., yeast, ringworm

Each of these infectious organisms can cause one or more specific diseases if it is introduced into a susceptible host under favourable circumstances. The diseases may not occur right away because time is required for the organisms to become established (this is called the incubation period). The incubation period may be as short as a few hours (e.g., food poisoning) to a few days (e.g., influenza) or as long as several years (e.g., AIDS).

On the other hand, the disease may never develop because of the host's ability to successfully fight it off — the immune response.

It is also possible that the disease will be only partially controlled and the person may become a carrier. A carrier would have no symptoms but would nonetheless be capable of spreading the disease (e.g., hepatitis B) to others.

Prevention of infection

Early recognition of the symptoms of communicable disease is important for two reasons:

- The patient can be referred to medical aid as soon as possible
- Fellow workers can be protected as early as possible from exposure to disease

In remote areas, it may be necessary to care for the contagious patient for some time. Special precautions should be taken to protect the attendant and also other workers.

The probability of spreading infection can be reduced by strict adherence to accepted infection control precautions. Protocols for handling infectious, or potentially infectious, materials should be in place and rigidly followed.

Infection control precautions

Evolved from universal precautions, these are used for the care of all patients, regardless of their presumed infection status. They apply to:

- Standard precautions (evolved from universal precautions) are used for the care of all patients, regardless of their presumed infection status. They apply to:
  - Blood
  - All bodily fluids, secretions, and excretions except sweat, regardless of whether they contain visible blood
  - Mucous membranes
  - Non-intact skin

Non-intact skin is defined as:

- A healing wound less than three days old
- A skin lesion causing disruption of the epidermis. Examples include dermatitis, hangnails, and chapped or abraded skin

Transmission-based precautions

Transmission-based precautions are additional precautions used only for patients known to be, or suspected of being, infected or colonized with serious pathogens that can be spread by airborne or droplet transmission or by contact with dry skin or contaminated surfaces.

Procedures for the prevention of infection

All bodily materials should be treated as if known to be contaminated at all times. The use of personal protective equipment is mandatory.

- Hand washing — This is the single most important means of preventing the spread of infection. It must be done consistently before and after caring for each patient, if gloves tear during patient care, before eating or handling food, after using the washroom, and as necessary when hands are contaminated. Both washing hands and wearing gloves interrupt the transmission of organisms (see page 196).
- Gloves — In the first aid setting, non-sterile, waterproof, disposable gloves are used when treating a patient — when the attendant's hands may come in contact with the patient's mucous membranes, non-intact skin, blood, bodily fluids, secretions, excretions, or items that may be contaminated. Any breaks in the skin of the attendant's hands — e.g., dermatitis — must be covered with a waterproof dressing and then gloves must be worn (see page 196, Gloves).
- The incidence of allergy to the latex in gloves is increasing. Gloves made from alternative materials (nitrile, neoprene, polyethylene) may be substituted for the latex gloves.
- Masks — It is recommended that the attendant wear protective equipment when a patient is coughing up blood or other secretions. The patient should wear the mask if they are suffering from an infectious respiratory illness and is coughing or sneezing.
- Needles, syringes, and sharps — All workers should take precautions to prevent injuries caused by:
  - Scalpel blades
  - Glass or metal objects around the incident site
  - Other sharp instruments or devices used during and after procedures
  - Used instruments during cleaning
  - Used needles during disposal

All syringes, needles, scalpel blades, and other sharp items should be placed in puncture-resistant containers for disposal (see Figure 44-1). The puncture-resistant containers should be located as close as practical to the area of use — e.g., in the ambulance or at the injury scene.

Figure 44-1 Puncture-resistant container

- Enteric precautions — Enteric precautions should be used to prevent the spread of disease (e.g., hepatitis A) transmitted by direct or indirect contact with infected feces and contaminated articles. The patient must be instructed to use good personal hygiene procedures, especially careful and thorough hand washing after using toilet facilities or before eating. The patient must not share food, drinks, or personal belongings — e.g., toothbrush.
- Gowns — Non-sterile washable cloth or disposable
- paper gowns may be used to protect skin or prevent clothing from becoming soiled where contamination from bodily materials may occur.
- Protective eyewear or face shields — When splashes or spraying of blood, bodily fluids, secretions, or excretions are likely, protective eyewear such as goggles, face shields, and/or full-size corrective eyeglasses may be worn to protect the eyes and oral/nasal mucous membranes.
- Spills of blood and other bodily fluids — Spills of bodily materials must be cleaned up promptly. The person cleaning must wear waterproof gloves and the area must be cleaned of all visible material using disposable towels or other means that will ensure

the person has no direct contact with the blood or bodily fluids. Once it is visibly clean, the area must be disinfected with an appropriate germicide or a fresh 1:10 (0.5%) solution of household bleach and water. Plastic bags should be used to remove contaminated items. Hands should be washed after removing gloves.
- Laundry — Soiled linen should be handled as little as possible. Wet linen should be transported in bags that prevent leakage. All laundry should be cleaned using hot water and normal cycles, following washer and detergent instructions.

Isolation policies

First aid rooms must not be used as isolation rooms because other workers may require the rooms for emergency care.

Strict isolation in a non-hospital setting is difficult to maintain but, in the case of a serious, highly communicable disease, every effort should be made to adhere as closely as possible to the ideal protocol, depending upon the facilities and equipment available to the attendant. The less exposure the infectious patient has to other people, the better.

Bloodborne pathogens

A bloodborne pathogen is an organism present in human blood that can cause disease in humans.

Bloodborne pathogen exposure

An injury is considered to be a bloodborne pathogen exposure incident if:

- It is a percutaneous (through the skin) injury caused by a sharp object that has come in contact with blood or other potentially infectious material
- It is a human bite
- There is mucous membrane (eyes, nose, or mouth) or non-intact skin contact with blood or other potentially infectious material
- Other potentially infectious materials include:
- Visibly bloody bodily fluids
- All bodily fluids in situations where it is difficult or impossible to differentiate between bodily fluids

Management

The attendant may have to care for a patient with a bloodborne pathogen exposure or self-administer first aid if they are the one exposed.

1. Flush the mucous membrane or wash the injury site with clean water and mild soap.
2. Dress the wound as necessary.
3. Dress the wound as necessary.
4. Occasionally, there are treatments for exposure to blood and bodily fluids, especially if the source patient is known to have or has risks for HIV or Hepatitis. Refer the patient to, or seek medical attention at the closest hospital emergency room, within two hours.

Food poisoning

The attendant should suspect food poisoning when a group of people develop similar symptoms, all within a short period of time.

Symptoms usually include vomiting and/or diarrhea, and/or abdominal cramps, in the absence of fever.

Treatment

The basic principles of treatment for food poisoning are as follows:

1. Restrict solid food intake.
2. Encourage clear fluid intake — e.g., water, juice, soft drinks, clear soups. Give small amounts frequently rather than a lot at once, and avoid all milk products.
3. Provide medication, such as anti-nauseants.
4. Ensure adequate rest.
5. The patient should be referred for medical treatment if any of the following signs and symptoms appear:
   - Blood in stool
   - Vomiting blood
   - Fever
   - Marked weakness
   - Severe abdominal pain
   - Dehydration

The most commonly encountered types of food poisoning are usually mild and self-limited, and symptoms usually resolve within a few days. In isolated areas where the quality of drinking water is questionable, consider parasitic infections (e.g., giardia). If the patient has recently travelled to a developing country, consider more serious causes (e.g., hepatitis, typhoid) and promptly refer the patient to medical aid.

Gastroenteritis

Gastroenteritis is a general term applied to a variety of clinical entities caused by a number of different agents. A few causes of gastroenteritis are:

- Viral, bacterial, or parasitic infection
- Food intolerance

- Organic poisons — e.g., shellfish or mushrooms
- Inorganic chemicals and toxins — e.g., nitrites, MSG
- Side effects of some drugs — e.g., antibiotics
- Stress

Parasites

Scabies

Scabies is an infestation of the skin caused by a microscopic mite. It can be identified by these signs:

- Small pimples and/or blisters, the visible sign of skin penetration (fine bumps may also be palpable on the skin surface in the early stages, before anything is visible)
- Linear tracks, the visible sign of mites burrowing under the skin
- Lesions, most frequently between the fingers and toes; on the anterior surfaces of the wrists, elbows, and ankles; and on the breasts, the male genitals, and the abdomen, back, and buttocks (the face and palms are usually spared)
- Persistent itching, which becomes severe and is usually worse at night (this itching is the most common sign)

Mode of transmission

The infection can be spread by direct skin-to-skin contact and by sharing the same bed, clothes, or towel. Merely examining a patient with scabies does not put the attendant at risk, particularly if proper hand-washing techniques are observed following the examination.

Treatment

The treatment of choice is available without a prescription. The drug of first choice is Permethrin 5% cream. It is applied to the entire body, from chin to toes, with emphasis on skin creases, between fingers and toes, between buttocks, and under breasts and external genitalia. It should be left on the skin for 8 to 14 hours. Normal bathing may be resumed after this time. If new burrows appear after one week, the cream may be reapplied. Clothing and linen should be thoroughly laundered using hot cycles of the washer and dryer.

Lice (pediculosis)

Lice are tiny insects that infest the hair, skin, and clothing. There are three distinct types:

- Head lice
- Body lice
- Pubic lice (crabs)

Head lice

Head lice generally prefer the fine hairs on the head, particularly around the ears. They also infest the eyebrows and eyelashes. Adults are 3 mm (⅛ in.) in length and, if observed closely, can often be seen moving. Nits (eggs) are grey-white, oval, and attached firmly to the hair, usually close to the scalp. They may look like dandruff but they cannot be flicked or pushed off with a finger. One of the first signs of a head lice infestation is that the head itches, prompting the patient to scratch it.

Mode of transmission

Head lice are transmitted between hosts by head-to-head contact. Their presence can be suspected in situations of overcrowding in dwellings, where hygiene facilities are less than adequate, and when grooming items (combs and brushes) might be shared.

Treatment

The drug of first choice is Permethrin cream rinse. The patient's hair should be washed with shampoo, rinsed with water, and dried with a towel. Permethrin rinse is next applied in sufficient volume to saturate the hair and scalp, left on for 10 minutes, and then rinsed off with water. A single treatment is sufficient. Combing of nits is not required but may be done for cosmetic reasons.

Body lice

Body lice are not found on the body but, instead, in the clothing. They anchor themselves on the clothing and reach across to suck blood from the infested person. The patient may thus be covered with scratch marks but have no lice found on their body.

Mode of transmission

Body lice spread by intimate contact or by sharing infested clothing. It is important to prevent the transfer of live body lice. These lice can live for up to 7 to 10 days away from the host and their eggs up to 10 days away from the host. Infected clothing should be placed in a plastic bag until laundered.

Treatment

Because body lice live in clothing, no treatment is needed other than that the patient should have a bath and be given fresh clothing and new bedding. Lice and nits in clothing can be destroyed by laundering in hot water (60°C/140°F) for 20 minutes. Dry cleaning or hot clothes dryers will also destroy lice and nits.

Pubic lice (crabs)

Pubic lice can infest the hairs of the pubic area, armpits, eyelashes, and eyebrows. In a hairy person, they may be found over the entire body.

Mode of transmission

Pubic lice are most frequently transmitted by sexual contact.

Treatment

To get rid of pubic lice, Permethrin cream rinse should be applied to affected areas.

Fungal infections

Scalp ringworm

Scalp ringworm is a fungal infection. In spite of the name, it is not a worm. It almost always occurs in children and appears as round, gray, scaly bald patches on the scalp. The patient should be referred to a physician for treatment and should not use another person's hat or comb, or allow another person to use their hat or comb.

Body ringworm

Body ringworm is a fungus that causes ringed, scaling, itchy areas on exposed skin surfaces. It is often transmitted to humans from infected household pets. Treatment is the same as for scalp ringworm.

Jock itch

Jock itch is a fungal disease that causes marked itching in the groin. It is characterized by sharply demarcated, reddish lesions with clear centres. This fungus affects athletes and other persons who perspire excessively. Mild cases can be treated with local drying measures and an antifungal medication.

Athlete's foot

Athlete's foot is a fungal disease that causes itching, burning, and scaling between the fingers and toes, and can lead to nail destruction. Treatment and prevention are both accomplished through personal hygiene, including thorough washing and thorough drying of the affected areas. The fungus that causes the condition cannot survive in a dry environment. It is frequently encountered in public showers and changing rooms in gymnasiums and swimming pools.

Treatment of fungal infections

Although a variety of anti-fungal applications are available, some even without a prescription, patients should be advised to seek medical advice and treatment for these conditions. Incorrect self-diagnosis and treatment can result in unwanted complications or delayed recovery.

Part 14

Diabetes

Diabetes

Diabetes is a systemic disease where the ability to regulate blood glucose (blood sugar) is impaired. The high blood glucose levels damage many tissues and organs in the body. People with diabetes have an increased risk of heart disease, atherosclerosis of the blood vessels, stroke, vision impairment, and kidney damage.

The role of insulin and blood sugar

Glucose is a cell's primary source of fuel. From glucose, the body's cells obtain the energy necessary to perform their vital functions. Without glucose, the cells' energy stores become depleted and they begin to malfunction. Certain cells, such as brain cells, are especially dependent on adequate glucose levels to maintain normal function. The signs and symptoms of low levels of blood sugar (hypoglycemia) usually involve the nervous system.

Insulin is a hormone produced by specialized cells in the pancreas, an organ in the abdominal cavity. Insulin's specific function is to transport glucose into the body's cells. Without insulin, the body's cells are unable to take up glucose, and cell dysfunction ensues.

Diabetes is caused by a deficiency or lack of insulin secretion from the pancreas. Without sufficient insulin in the bloodstream, the body's cells cannot use glucose, which results in high levels of blood sugar.

Types of diabetes

There are two types of diabetes:

- Type I, previously called juvenile-onset diabetes
- Type II, previously called adult-onset diabetes

Type I Diabetes

Patients with type I diabetes usually develop the condition in childhood or adolescence. Their diabetes is caused by a total lack of insulin production. All of these patients require supplemental insulin to control their disease. These diabetic patients are therefore insulin-dependent and take injections of insulin to control their blood sugar levels.

Type II Diabetes

Type II diabetes usually appears in adulthood. The body is still able to make insulin but in amounts insufficient to provide the necessary control of blood sugar. This is mainly due to insulin resistance by the receptor cells, which collect glucose out of the blood and store it. The body of many people with type II diabetes requires higher than normal levels of insulin to control its blood sugar levels, so the pancreas is unable to keep up with the demand. Many of these people can control their diabetes by diet alone; others may require oral medication. In the most severe cases of type II diabetes, patients may be insulin-dependent and require insulin injections to control their disease.

Diabetes is essentially incurable but it can be controlled by following a careful diet and, where necessary, using medication — insulin or specific pills. People with diabetes must monitor their blood sugar. Some people may monitor their blood levels of glucose by testing blood samples obtained from a finger prick. These people have special portable machines called glucometers, which analyze the level of glucose in the blood sample.

Emergencies in patients with diabetes

Patients with diabetes may develop complications of the disease, which may present as a medical emergency. Two emergencies that the attendant will most commonly encounter are:

1. hypoglycemia — low blood sugar
2. hyperglycemia — high blood sugar

When managing a patient with diabetes and a decreased level of consciousness, the attendant can often find it difficult to determine if the patient is suffering from hypoglycemia or hyperglycemia.

It is important to note that patients with diabetes are not immune to head injury, stroke, seizure, or any of the other causes of decreased consciousness. The attendant must consider all of the possible causes when assessing a patient with a decreased level of consciousness who happens to have diabetes.

Hypoglycemia

Hypoglycemia is a potentially life-threatening emergency because of the brain's dependence on adequate levels of glucose. Hypoglycemia is also called insulin shock or insulin reaction. However, the attendant must realize that patients do not necessarily have to be on insulin to develop hypoglycemia. Adults with diabetes who take pills to control their blood sugar are also at risk for hypoglycemia. People who do not have diabetes but who are heavily intoxicated with alcohol may develop hypoglycemia. People with diabetes who drink alcohol excessively are at very high risk of developing hypoglycemia.

Causes

The major causes of hypoglycemia are:

- People with diabetes who take hypoglycemic pills or insulin and have insufficient food intake
- People with diabetes who take hypoglycemic pills or insulin and who have worked or exercised strenuously and used up all their available glucose
- People with diabetes who have taken too much insulin or extra doses of their hypoglycemic medications
- There are other rare medical conditions where blood sugars drop, such as sepsis

Signs and symptoms

The attendant must suspect hypoglycemia whenever a patient with diabetes becomes confused or behaves irrationally. Because of the brain's dependence on adequate levels of glucose, failure to quickly recognize and treat hypoglycemia will result in progressive deterioration of the patient's condition and possibly death.

The earliest signs of hypoglycemia are:

- Hunger
- Pale, clammy skin
- Dizziness, trembling, weakness
- Confusion, restlessness, irrational behaviour

As hypoglycemia progresses, the patient may develop slurred speech or collapse, or become unresponsive. Seizures and profound sweating are also quite common. The patient's respiration and pulse may increase somewhat but, they often remain normal despite the changes to the patient's level of consciousness.

IIt is not uncommon for an attendant to mistakenly diagnose the patient with diabetes and hypoglycemia as being intoxicated by alcohol because the signs and symptoms of alcohol intoxication are quite similar to those of hypoglycemia. Certainly, diabetes and alcohol intoxication can coexist in any one patient. Failure to promptly treat hypoglycemia may result in permanent brain damage or death.

The responsible attendant will want to identify co-workers who have diabetes, especially those on insulin or hypoglycemic medication, and will suspect hypoglycemia whenever they become ill. The attendant should recommend medical alert bracelets or cards.

Management

The basic principle of treatment is to provide glucose in any form. If the patient is conscious, any sugar-containing substance will suffice — honey, syrup, sugar and water, fruit juice, soft drinks (not diet drinks), or candy. There are glucose tablets that are available at the pharmacy without prescription that many diabetics carry. The attendant should not be concerned about giving too much sugar. Sips of juice or small amounts of candy are insufficient. A full glass of juice with sugar added or a whole candy bar is usually required. All these patients, even if they regain their normal status, should be referred for medical assessment. All patients with diabetes and a decreased level of consciousness are in the rapid transport category.

If the patient has a decreased level of consciousness and is thus not able to take anything by mouth, the attendant has limited options. For hypoglycemic patients in a remote workplace or where BCEHS resources are not readily accessible, it is recommended that a small amount of sugar be placed under the lateral or ¾-prone patient's tongue. Concentrated glucose jelly or glucose tablets are commercially available. Care must be taken when administering sugar because such patients are at very high risk of choking or of aspirating liquid, even if the patients are placed ¾-prone or suction equipment is available. The most effective way to give glucose to these patients is intravenously.

After conducting the primary survey and managing any life-threatening conditions, the attendant should position the patient in the lateral or ¾-prone position. With the patient in the lateral or ¾-prone position, The attendant should attempt to place a teaspoon of sugar or concentrated sugar solution (e.g., honey or syrup) under the patient's tongue and the area between the inside of the cheek and the teeth and gums while awaiting transport or en route. The attendant must take care not to place the sugar at the back of the throat because it may cause the patient to choke. Special attention must be devoted to maintaining the airway of the comatose patient.

Assisted ventilation may be required if breathing is inadequate.

Hyperglycemia

When the blood sugar of a person with diabetes rises to high levels, a chain of events is triggered in the body's metabolism. In the absence of adequate amounts of insulin, the body's cells are unable to use glucose and they begin to malfunction. High levels of blood glucose cause excessive urination, which in turn causes severe dehydration and thirst. The changes to the body's metabolism result in acidic waste products accumulating in the blood. This causes a loss of appetite, nausea, vomiting, and deep, rapid breathing. The breath has a characteristic fruity, sweet odour, caused by the accumulation of these acid waste products.

This sequence of events develops gradually, usually over the course of a few days. However, it can progress to coma and, ultimately, death if not adequately treated. At this extreme, hyperglycemia becomes a true emergency.

Causes

Diabetes can be controlled only by following a strict diet and taking medications as prescribed. The most common causes of hyperglycemia are:

- Not following a strict diet (i.e., taking in too many calories or too much sugar)
- Excessive alcohol intake
- Not taking prescribed medications or insulin correctly
- Infection — e.g., the flu, pneumonia, gastroenteritis

Signs and symptoms

The earliest signs of hyperglycemia are:

- Thirst
- Excessive urination
- Loss of appetite
- Weakness, dizziness

As the hyperglycemia progresses and the body's metabolism alters in other ways, the following signs and symptoms develop:

- Nausea, vomiting
- Deep, rapid breathing
- Dry mouth
- Breath has a characteristic fruity sweet odour
- Weak, rapid pulses
- Warm, dry skin
- Decreased level of consciousness, coma

The differences between hyperglycemia and hypoglycemia are shown in Table 45-1.

Failure to treat hypoglycemia risks permanent brain damage to the patient, and the possible death of the patient. Providing additional sugar to the hyperglycemic patient with a decreased level of consciousness will not cause any additional harm. The attendant must administer sugar to all patients with diabetes and a decreased level of consciousness unless the history and signs and symptoms clearly indicate hyperglycemia or other causes of decreased consciousness.

Management

The attendant can do little to treat hyperglycemia. These patients require prompt treatment in hospital with intravenous fluids and insulin. The attendant must manage the patient's ABCs and complete the primary survey. The patient with a decreased level of consciousness requires special attention to the airway. Assisted ventilation may be required.

Comparing hypoglycemia and hyperglycemia

History	Hypoglycemia	Hyperglycemia
Food intake	Insufficient	Excessive
Insulin or medications	Excessive relative to food intake	Insufficient
Onset of symptoms	Rapid	Gradual
Symptoms		
Thirst	Absent	Present
Hunger	Present	Absent
Vomiting	Uncommon	Common
Urination	Normal	Excessive
Physical Signs		
Odour of breath	Normal	Fruity, sweet
Breathing	Normal	Rapid
Pulse	Normal, may be increased, slightly strong pulse	Rapid, weak
Skin	Pale, clammy, wet	Warm, dry
Seizures	Common	Uncommon
Response to Treatment with Sugar		
Patient's condition	Rapid improvement	No change

Table 45-1

Part 15

Mental Health Emergencies

Part 15 Mental Health Emergencies

Critical incident stress

First aid attendants may be involved in situations or incidents that can cause an ongoing reaction in themselves or other people who were present. These are called critical incidents and may include incidents of serious injury or death, as well as near misses where there was a potential for death or injury. Examples include bomb threats, hostage takings, and other life-threatening situations. A person's reaction to the incident may be characterized by a range of emotional, cognitive (thought), behavioural, and physical symptoms. These symptoms may interfere with their ability to function normally and may occur immediately or later.

Effects of critical incident stress

Physical effects

- Nausea, stomach upset, weight loss, diarrhea
- Dizziness, shakiness, weak feeling in legs, sweating
- Pounding heart, hyperventilation, feeling of fatigue
- Headaches, general aches and pains, chest pains

Cognitive effects

- Difficulty concentrating, absent-mindedness
- Confusion, difficulty making decisions
- Difficulty performing tasks

Emotional effects

- Feeling anxious, jumpy, irritable
- Feeling guilt, anger, fear, grief
- Feeling depressed, having mood swings, nightmares, flashbacks
- Feeling lost, helpless, abandoned

Behavioural effects

- Increased use of drugs and/or alcohol
- Difficulty going certain places, or withdrawal from family, friends, colleagues
- Difficulty being alone

More than 80% of individuals affected by a critical incident will have some reaction within 24 hours. If the reaction is not appropriately dealt with, it may progress to post-traumatic stress disorder which may continue for months or even years.

Management of critical incident stress

A critical incident should be dealt with using defusing and debriefing sessions.

Defusing session

A defusing session is a short (30 to 45 minutes) confidential, non-judgmental meeting of the workers affected by the incident. It is facilitated by specially trained personnel and should be held as soon as possible after the incident. The purpose of the session is to explain the physical, cognitive, emotional, and behavioural reactions that may occur and to discuss with workers how to best take care of themselves. Information about available resources (e.g., employee assistance programs, family physicians) is given in case assistance should be required.

Debriefing session

A debriefing session is also a confidential, non-judgmental meeting that is held to lessen the trauma and stressful effects of the incident. It is held for those who were directly involved, to enhance their recovery. The session can be done on an individual or group basis and is facilitated by personnel trained in debriefing. Ideally, the meeting is held 24 to 72 hours after the incident on a voluntary basis. The session focuses on the emotional well-being of the workers and is not to be used to discuss the cause of or blame for the incident.

These sessions are not a substitute for therapy.

Individuals may need ongoing support and counselling. In these cases, workers should be directed to a mental health professional.

Resources for information and assistance

- Local corporate employee and family assistance program providers
- Family physicians
- Municipal health services
- Community mental health providers
- Municipal fire departments
- Local crisis centre phone lines
- Emergency departments at local hospitals
- Clergy
- Workers' compensation boards

Mental health emergencies

When an individual experiences an injury or illness, it is usually emotionally stressful. The stress arises not only in response to the bodily disorder but also from feelings that the patient is in a situation over which self-control has been lost. Co-workers, bystanders, or family members may be similarly stressed, as they feel unable to help. Both the patient and these other people may feel they are in crisis. Whether the crisis is real or imagined, it must be managed. By practising good communication and personal interaction skills (see page 19, Communication), the attendant will provide emotional support, lessen emotional stress, and initiate appropriate crisis management.

Signs and symptoms of emotional stress reaction in the patient

Anxiety

Anxiety is one of the most common responses to injury or illness. It may arise from specific fears (e.g., fear of pain, permanent disability, or even death) or from generalized fear (e.g., fear of loss of control over the situation).

Depression

Patients may be depressed as a consequence of loss of normal body function.

Anger

Patients may be demanding, resentful, and hostile to the attendant or others around them.

Denial

Denial is the reaction by which patients minimize the injury or illness. It is commonly seen with the onset of symptoms of a heart attack and in victims of violence.

Signs of emotional stress reaction in co-workers, bystanders, or family members

Persons at the scene with the patient may exhibit a number of responses to the stress of the injury or illness. They may exhibit all of the emotional responses described above for the patient. More commonly, however, there is often a feeling of guilt in co-workers or family members who may feel partly responsible for the patient's injuries. This particular emotion may cause them to be very aggressive in their demands for action. They may question the attendant's competence and demand that the patient be sent to hospital before appropriate assessments and interventions have taken place.

A cool, unflustered manner, with persistent use of communication and personal interaction skills, will greatly alleviate fear and stress in the patient and others at the scene, and put the attendant in control. The attendant must try not to become angry or upset with people displaying inappropriate behaviour, remembering that this only reflects their fear and feelings of inadequacy.

Emotionally disturbed patients

The various emotional reactions displayed by an injured or ill patient, described as emotional stress reactions, are quite common and might be encountered by the attendant. In most cases, appropriate communication and personal interaction skills will reassure the patient.

At times, patients may not behave as expected and their emotional responses may interfere with your assessment and treatment. These patients still respond to people around them and are not apparently dangerous to themselves or others. They may be very anxious or fearful and may not calm down as care is initiated. These patients are experiencing an emotional emergency. This reaction may represent an underlying psychiatric disturbance but it may result just from the stress of the immediate injury or illness. Never identify such a patient as "psycho," "mental case," or other non-medical label.

These patients may require more time, understanding, and reassurance to cope with the stress of the injury or illness. Continue to use the skills outlined previously (see page 19, Communication). If no critical interventions are required, spend more time conversing with these patients, calmly listening to them and providing more reassurance.

Psychiatric emergencies

Many psychiatric disorders may cause a wide variety of abnormal behaviour. Conditions that the attendant may encounter include the following:

- Suicidal act — The patient may have made a suicide attempt or may be threatening suicide.
- Manic behaviour — The patient is often very agitated, speaking rapidly and in incomplete sentences. The patient may pace and have an expanded (grandiose) perception of personal importance or capability.
- Depression — The patient may be withdrawn, with low self-esteem.
- Paranoia — The patient may believe that others, including the attendant, are trying to harm or even kill them.

Patients in a true psychiatric emergency may be very volatile and may exhibit a great variety of behaviour in a short period. They may appear calm one minute, then become violent the next.

Behaviour that should no longer be considered to be a stress reaction or an emotional emergency but more likely a psychiatric emergency includes patients who:

- Take no action to help themselves and not allowing others to care for them
- Continue to be enraged or very hostile or threatening
- Try to hurt themselves, others, or the surroundings
- Withdraw and no longer responding to others or the surroundings
- Are very depressed, with symptoms of hopelessness, helplessness, unworthiness, or guilt
- Behave irrationally and/or inappropriately for the circumstances

If, at the scene, a patient displays inappropriate behaviour, the attendant may not be able to rule out an illness or an injury. The attendant may assume that the patient is exhibiting signs of a psychiatric emergency. The psychiatric emergency may have a medical or physical problem as its cause.

It is important that the attendant ensures their own safety and the safety of others first. Then, attempt to rule out physical or medical conditions that may be causing the disruptive behaviour.

Disruptive patients

Disruptive patients behave in a manner that presents danger to themselves and others or causes a delay in treatment. The standard skills for good communications and personal interaction outlined earlier (see page 19, Communication) may be ineffective with such patients but should still be tried.

The major medical and physical causes of disruptive behaviour include:

- Abuse of alcohol or other drugs (e.g., stimulants, cocaine, diet pills, psychedelics, narcotics). Substance abuse is the most common cause of disruptive behaviour. Nevertheless, the attendant must always suspect underlying associated conditions (e.g., head injury).
- Diabetes, especially insulin reactions causing hypoglycemia. Hyperglycemia from diabetes may also cause disruptive behaviour.
- Seizures.
- Head injuries.
- Severe infections and/or very high fever.
- Neurological disorders (e.g., strokes). These are seen primarily in the elderly.

Clues that may point to a physical or medical basis for disruptive behaviour include:

- Sudden onset of symptoms — Psychiatric illness usually develops over weeks or months.
- Unusual odour on the breath (e.g., alcohol or a fruity odour).
- Impaired memory — With most psychiatric disorders, the memory is intact and the patient is oriented to time, person, and place.
- Incontinence.
- Visual hallucinations — In psychiatric disorders, hallucinations are usually auditory, such as when the patient hears voices.

Management of the disruptive patient

Of greatest concern is the aggressive or violent patient. Effective evaluation and treatment of the violent patient requires the attendant to follow a priority action approach. The first priority is the protection of self and others at the scene, then adequate control of the patient. This may require physical restraint. The second priority then becomes the assessment of the patient and the prompt transport to hospital.

The attendant's first obligation is to protect themself and others when the patient exhibits violent behaviour, has threatened to be violent, or is considered potentially violent. If the police can respond to the scene within a few minutes, the attendant should have everyone leave the immediate area and wait for the police to arrive and manage the incident.

Often, just the presence of police in uniform will help subdue the violent individual.

If the police will be delayed (e.g., the workplace is remote) the attendant may decide to use physical restraint with adequate protection. Adequate protection requires the summoning of adequate force. At least five able-bodied individuals will be needed to physically restrain the patient.

Procedures for assessing the unrestrained violent or potentially violent patient

- Think of your own safety. Do not isolate yourself from other sources of help.
- Always be alert for weapons or an indication that the patient will use physical force. If the patient threatens, immediately withdraw and stay in a safe area until the police can control the scene. Do not try to seize a weapon.
- Do not put yourself in danger by an action that the patient may consider threatening.
- Always ensure that you have an escape route and do not let the patient get between you and it.
- Maintain an open exit. Do not sit or stand in a location that blocks the patient's exit, and leave the door open. If the patient bolts out of the room, do not try to intervene. The patient's recapture and restraint should be left to the police.
- Maintain an adequate distance. The attendant should not try to shake hands or reach towards the patient. Stand at least 2.5 m (8 ft.) away to avoid pressuring the violent patient.
- Listen and sympathize. That will allow the patient to ventilate anger and frustration verbally instead of physically.
- Promise anything if the patient becomes more violent before adequate force arrives. This may distract the patient or defuse the situation temporarily until adequate force arrives. It may buy time.
- Avoid eye contact. The usual benefits of good eye contact can have the opposite effect with a violent patient. Looking at them directly in the eye may represent a personal challenge or threat and precipitate further violence.
- Maintain a submissive posture. Since the violent patient is likely to respond violently to a challenge, the attendant who adopts a rather submissive posture may reduce this perceived challenge. A slightly slouched posture turned somewhat away from the patient may be effective.
- Be decisive. Decisive and swift action is appropriate when adequate numbers of helpers are available to bring the situation under control. Violent patients are best managed with swift restraint and rapid transport to a medical facility for evaluation.

If a patient has been successfully restrained by others prior to the attendant's arrival, those restraints should not be removed until the patient has been assessed in a hospital setting. With appropriate help, the restraints may need to be replaced so that they cannot injure the patient.

If the patient becomes violent in the presence of the attendant, law enforcement must be summoned and a plan made for restraint by a coordinated team of helpers. The worst mistake the attendant can make is to try to physically subdue the patient single-handedly. Such ineffective measures always make the situation more unstable. Anxiety and belligerence increase because the patient recognizes that they are out of control and unmanageable. In such a state, the patient may harm the attendant or other bystanders.

Physical restraint of a violent patient should be carried out by law enforcement. Adequate restraint requires that the patient be subdued with an overwhelming and coordinated force.

If violent behaviour is expected but has not been observed, the attendant should summon law enforcement in advance to stand by as the patient is evaluated.

Physical restraint involves some risk to the patient and a small probability that the restraint will increase the patient's anxiety and belligerence. In most cases, however, the patient will become calmer after restraint. The patient knows that someone else is in charge and that they do not need to fear these uncontrolled impulses. Following restraint, the patient may plead for release, promising to be calm if the restraints are removed.

The patient must be informed that the restraints need to be left in place until an adequate medical evaluation can be conducted.

The restrained patient must be carefully searched for needles or weapons. Knives and other weapons must be removed and kept away from the patient.

If you help a police officer to restrain a patient, use restraints that will not cause soft-tissue damage. Soft restraints for the wrists and ankles can be made from triangular bandages. Handcuffs should not be removed until soft restraints are well secured and all concerned are certain that the patient will not be able to escape. Once the appropriate restraints are placed on the patient, they should not be removed, even if the patient appears to be acting rationally. The removal of the restraints is the responsibility of the attending physician or the police.

Guidelines for managing non-violent disruptive patients

- Use the communication and personal interaction skills recommended (see page 19, Communication).
- Remain as calm as possible. Remain well-mannered and show respect for the patient.
- Do not be judgmental. The patient may be convinced their thoughts are valid, no matter how ridiculous they seem to you.
- Do not force the patient to make decisions if that ability has been lost. The attendant should make all the decisions. Be persuasive and supportive. However, if it seems important for the patient to maintain some control, allow the patient to participate in non-essential decisions.
- Try to obtain as much history as possible from bystanders or co-workers regarding any past history of psychiatric disturbance or medications for the same.
- Consider all patients with psychiatric symptoms to be at risk for fleeing. Have someone stay with the patient at all times.
- If there is a possibility of concealed weapons, ask the police to check the patient. If any weapons are found in the course of assessment or treatment, they should be confiscated. Patients likely to have concealed weapons are individuals with suicidal or paranoid thoughts, or severely disturbed individuals.
- Ask specific questions, requiring more of an answer than a simple yes or no, to help determine whether the patient has lost contact with reality. Encourage the patient to explain their feelings or situation.
- Do not be uncomfortable if there are lapses or silent periods in the patient's speech. Remain attentive but relaxed.
- Once the attendant has an understanding of the patient's problem, explain it to the patient. The attendant should emphasize the need for medical care and the steps to be taken to get the patient to hospital.
- If the scene is very noisy or busy, the attendant may wish to take the patient to a quieter area to conduct the interview or assessment. Be sure that help is readily available and do not let the patient come between you and the exit.

Part 16

Patient Handling and Transportation

Lifts, carries, and stretchers

This section outlines the basic techniques of lifts, carries, and stretchers. To avoid injury, every attendant needs a thorough knowledge of the biomechanics of lifting. Back injury from poor lifting technique is the most common cause of disability among pre-hospital emergency-care providers.

Biomechanics of lifting

- Be aware of your physical capabilities and do not try to handle too heavy or awkward a load. When in doubt, seek help.
- Position your feet shoulder-width apart for balance and to maintain a firm footing (see Figure 48-1 Feet at shoulder width).

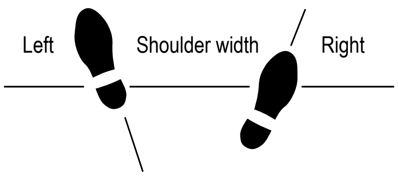


Figure 48-1 Feet at shoulder width

- Bend your knees.
- While lifting or holding, keep your back straight and rely on leg and shoulder muscles (see Figure 48-2 Use your legs to lift). Tighten the muscles of the buttocks and abdomen to brace the back.
- Keep the patient close to your body.
- Do not twist your back while lifting. If you need to turn, pivot with your feet.
- Carry out all lifts and carries slowly, smoothly, and in unison with helpers.
- Where appropriate, try to slide or roll a heavy patient rather than lifting them.

Figure 48-2 Use your legs to lift

The following procedure will help ensure proper patient handling and lifting.

1. Inform the patient of what is going to be done.
2. Prepare the patient for transport.
3. Move the patient onto a lifting device and secure them to it.
4. Place the lifting device and patient onto the well-padded stretcher.
5. Remove the patient from the lifting device and secure them to the stretcher.
6. Lift and load the stretcher into the transportation vehicle and secure the stretcher to the vehicle.

Informing the patient

Prior to any movement, the attendant should always inform the patient of the manoeuvres that will be carried out. This communication allows the patient to understand and to assist if they are able. It also helps to dispel any fears the patient may have about being lifted and placed on a stretcher. The attendant must reassure the patient during the lift because the patient may have a fear of being dropped. By providing calm reassurance, the attendant ensures the patient's co-operation and comfort. The patient must be reassured regardless of their level of consciousness, as even patients with a decreased level of consciousness can often hear or understand what is happening.

Preparing the patient for routine transport

Prior to performing a lift, the attendant should follow these steps:

7. Place a blanket between the patient's legs.
8. Secure the legs together at the mid-thighs, knees, mid-calf, and ankles, using wide bandages.

Lifting the Patient

Patients in the rapid transport category are scooped up using a scoop-style stretcher or rolled onto the spine board because there is no time to do a practice lift and coordinate a large number of helpers. Non-RTC patients should be scooped or lifted onto the stretcher unless obstructions or an insufficient number of helpers makes this impractical.

When performing lifts or rolls, the attendant is responsible for instructing and coordinating helpers. The attendant must take the position closest to the most significant injury site. In the case of multiple injuries, the airway and/or C-spine control are the highest priority.

There are many methods of lifting and transferring patients to a carrying device, each with particular advantages. The location, availability of help, and the nature of injury will dictate the best method. Practising the various methods of lifting patients ahead of time will be helpful as preparation for an actual emergency. The attendant should consider training designated stretcher teams for emergency responses at the workplace.

Alternative lifts

The attendant may have to use alternative methods of lifting patients. They should be used only when the health and safety of the patient or attendant are in question. These are the alternative methods:

- Fore-and-aft lift
- Two-handed seat
- Four-handed seat
- Chair carry
- Drag carry

Two-person fore-and-aft lift

This method should be used with caution because of the strain it places on the lifters' backs. It can be used for patients who are in the semi-sitting position.

- The attendant is on the side of the patient and lifts the patient's shoulders.
- The helper is positioned at the patient's head, supporting the head and lifting the back of the patient.
- As the patient reaches a sitting position, the helper at the head drops to one knee and supports the patient against the helper's leg.
- This helper then passes their arms around the patient and grasps the patient's wrists. The right hand grasps the left wrist and vice versa.
- The attendant then passes their arms under the patient, one under the thighs and the other under the calves.
- The attendant and the helper squat. The head-end helper has the patient's back on their chest with the helper's knees on either side of the patient.
- On a signal from the helper at the patient's head, both rise simultaneously and place the patient on a stretcher (see Figure 48-3 Two-person fore-and-aft lift).

Figure 48-3 Two-person fore-and-aft lift

Two-handed seat

- The attendant and helper kneel on either side of the patient. Each must pass one arm around the patient's back, grasping the clothing.
- They pass their other arms under the patient's thighs and grip hands, either with a hook grip or wrist lock (see Figure 48-4 Two-handed seat). The patient places their arms around the attendant's shoulders.
- On a given signal, the attendant and helper rise, keeping their backs straight and lifting with their legs.

Figure 48-4 Two-handed seat

Four-handed seat

- The attendant and helper each kneel on one knee on either side of the patient and each should grasp their own left wrist.
- They now grasp each other's free wrist (see Figure 48-5).
- The patient places their arms around the attendant and helper's necks and rises so they can position their four-handed seat under them.
- At a given signal, the attendant and helper rise, keeping their backs straight and lifting with their legs (see Figure 48-6 Four-handed seat).

Figure 48-5 Grasp each wrist

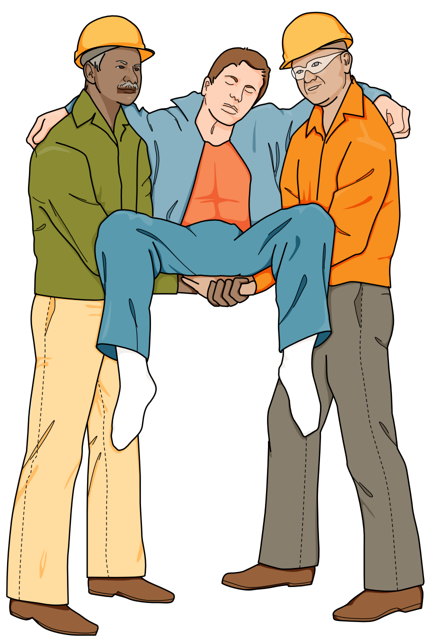


Figure 48-6 Four-handed seat

Chair carry

The chair carry is used to carry a conscious patient through narrow passages and down narrow stairs. It requires two people.

- The chair must be sturdy, light, and have a straight back.
- Place the chair beside the patient and with the fore-and-aft lift, place the patient on the chair. Alternatively, if the injuries permit, raise the patient's legs and attempt to carefully slide the back of the chair under the buttocks and back.
- The helper is at the feet, facing the patient. The first aid attendant stands at the patient's head.
- The patient is instructed to grasp the sides of the chair.
- The head-end attendant grips the top or sides of the chair-back and carefully tilts it backward, using their feet to brace the legs of the chair.
- The foot-end helper grasps the front legs of the chair as close to the floor as possible.
- On a signal from the head-end attendant, they lift the chair.

Drag carry

The drag carry is used to move a patient who cannot move voluntarily, and who must be rescued quickly from hazards such as fire, smoke, or gases. This method keeps the attendant and the patient low, where the air is freshest. It is also used in cramped spaces where the attendant cannot stand up.

- With the patient supine, the attendant quickly ties the patient's wrists together.
- The attendant, on their hands and knees, straddles the patient facing the head and places their own head through the patient's arms. The attendant then carefully raises the patient slightly with their neck.
- The attendant crawls on hands and knees, dragging the patient. When going down stairs, the attendant should crawl backward, supporting the patient's head.

Multi-person direct lift: Eight people

When a scoop-style stretcher is not available or is not practicable, a direct lift may be an option. Ideally, there should be eight people to do this lift, although it is also possible with fewer people alongside the patient, depending on the size of the patient. If possible, conduct a practice lift on a person of about the same size and build as the injured worker.

- One person kneels at the patient's head and one at the feet. The person at the head manually stabilizes the patient's head and neck by grasping the muscles at the base of their neck (trapezius muscles) with one hand and the head with the other hand. The patient's head is supported between this person's forearm and hand.
- The remaining six people will be beside the patient, three on each side. All six people will kneel on both knees. The attendant will take the position closest to the most significant injury site. The heaviest part of a person's body is between the neck and the hips, so the strongest lifters should be at these areas.
- The six helpers on either side of the patient slide their hands under the patient toward each other, palms up, until their fingertips touch.
- On a signal from the attendant, the patient is raised 15 cm (6 in.) off the ground. The patient must be lifted as a complete unit and supported in alignment. The helper at the feet will then slide the spine board or other appropriate device, under the patient until it is in the proper position.
- On a signal from the attendant, the patient is gently lowered onto the device. The patient is then secured to the carrying device.

Stretchers and lifting devices

There are many kinds of stretchers and lifting devices. There are five common types:

1. Scoop-style stretcher — e.g., Robertson Orthopedic™ — (see Figure 48-7a)
2. Spine board (see Figure 48-7b)
3. Basket stretcher (see Figure 48-7c)
4. Technical rescue stretcher (see Figure 48-7d)
5. Multi-level stretcher — wheeled cot (see Figure 48-7e)

All these devices will carry the patient's entire body.

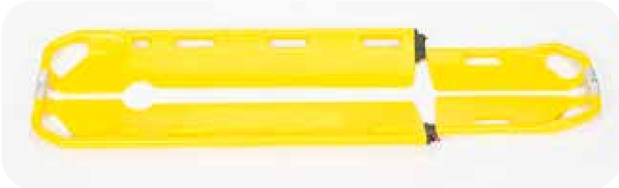


Figure 48-7a Scoop-style stretcher

Figure 48-7b Spine board

Figure 48-7c Basket stretcher

Figure 48-7d Technical rescue stretcher

Figure 48-7e Multi-level stretcher

Scoop-style stretchers

A scoop-style stretcher is an excellent lifting device suitable for lifting patients from the ground to another kind of stretcher or carrying device (see Figure 48-7a). It is used by many ambulance and fire services. This stretcher is a lifting device and is not designed for carrying patients over long distances.

The scoop is lightweight. It adjusts in length and separates into two halves. It is quick to assemble and requires minimal patient movement. It can be left in place in the basket or main stretcher to immobilize and lift the patient onto a hospital bed, or it can be removed for comfort, depending on the patient's condition and the transport distance.

To use the scoop, the attendant must read and understand the manufacturer's user instruction manual before the need to use it in an emergency arises. To prepare the device for a lift, it must be adjusted by disassembling and reassembling it to fit the patient.

Preparation

- Assess the patient's weight. If the patient weighs under 90 kg (200 lb.), two people are sufficient for the lift. If the patient weighs between 90 kg and 114 kg (250 lb.), four people are needed for the lift, one person at each side and one at each end. If the patient weighs more than 114 kg, a spine board may be considered for the lift.
- Place the scoop stretcher at the patient's side.
- Explain to the patient what you are going to do.

Disassembly

- Measure the stretcher against the length of the patient's body. Adjust it to be slightly longer than the patient.
- Press the locking mechanism to release the locking pins. Insert the locking pins into the closest holes.
- Place your foot between the stretcher and the patient. If the locking mechanism sticks, this prevents the patient from getting hit by the stretcher.
- Pull the stretcher halves apart.

Reassembly

- Move half of the disassembled stretcher around the patient. Do not move the part over the patient.
- Place each half of the stretcher under the patient.
- Ensuring that the patient is not being pinched, lock the end of the stretcher that supports the uninjured part of the patient first, and then lock the other end.
- Recheck that the locking mechanisms are locked.
- Ensure that the receiving stretcher is nearby and prepared.

Lifting and moving

- Squat at one end of the stretcher, direct a helper to squat at the other end, and direct additional helpers to squat at each side of the stretcher.
- Direct everyone to place their feet shoulder width apart, with their weight evenly distributed.
- Grasp the frame firmly.
- Communicate with the helpers to coordinate the lift.
- Have everyone keep their backs straight and use their leg muscles to lift.
- Sidestep to the receiving stretcher.

Spine board

The spine board is a lifting device and is not used for transporting patients (see Figure 48-7b). Extended periods on a spine board result in pressure sores and musculoskeletal injuries and pain. Most spine boards are made of rigid plywood or plastic. They should have bevelled edges on one side and one end for sliding under the patient. Most boards are approximately 1.8 m (6 ft.) long. If spine boards are used in conjunction with basket stretchers to move the patient a short distance, the board must fit inside the stretcher. Spine boards should have holes for patient-securing straps and hand holes for lifting.

Patient packaging for rapid transport

From the moment it is decided that the workplace attendant must rapidly transport the patient to hospital, only critical interventions should be performed. All other efforts must be directed at "packaging the patient" for safe transport as rapidly as possible.

If, during the primary survey, it is determined that the patient is in the rapid transport category the attendant must only do the following:

- Carry out critical interventions relating to problems with the airway, breathing, and circulation.
- Complete the primary survey.
- Rapidly but carefully prepare for rapid transport by "packaging the patient."
- Reassess ABCs.

The primary survey, critical interventions, and patient packaging should be completed in less than 15 minutes. Rapid, safe transport is the priority.

The attendant should immediately proceed to packaging the patient and direct others to arrange for appropriate transportation. The secondary survey should be conducted after the patient is packaged and en route to hospital, or while the patient is waiting for the transport vehicle.

The term patient packaging is used so that the attendant that is responsible for transporting the patient, think of the patient as a fragile, priceless article that must be shipped some distance and may be exposed to inadvertent rough handling and/or moved through all manner of positions. For example, in transit, the patient may be exposed to the shaking and thumping of a rough logging road or to air turbulence in an air evacuation. If vomiting occurs, the patient may also have to be rapidly turned as a unit into the lateral position to protect the airway, or the spine board may have to be put on its side to get it into an aircraft. For the patient with multiple trauma and suspected C-spine injury, it is imperative that the patient be secured, with appropriate padding, so that the patient does not move and associated injuries are protected and not aggravated.

The techniques used for patient rapid transport packaging supersede and replace all other immobilization and splinting techniques taught in this course once the patient is placed in the rapid transport category.

Advantages of rapid transport patient packaging

- The patient is rapidly prepared for transport.
- It is easier to manage the patient's airway while protecting their cervical spine.
- The method affords some chest wall stabilization for associated chest injuries.
- There is effective stabilization of other injuries, reducing their aggravation (e.g., spine injuries, pelvic fractures, or lower-limb fractures).
- The patient is protected from further injury en route.
- There is effective control of the delirious patient.

Equipment required

- A hard cervical collar of appropriate size.
- Scoop stretcher and long spine board.
- Solid bottom, padded basket stretcher.
- Straps: An adequate number of 2 m x 5 cm (6 ft. x 2 in.) heavy Velcro straps, spider straps, or safety-belt type straps with quick-release buckles.
  - The straps are preferred. However triangular bandages and/or 5 cm (2 in.) tape may be used. Tape may not stick to the spine board in a wet or cold environment.
- Six regular blankets or comparable padding.
  - One or more folded and placed on the bottom of the basket stretcher for additional padding under the patient if needed.
  - One folded to fit between the patient's legs.
  - One folded lengthways to run from the shoulder to below the ankles on each side — total of two.
  - One folded as a horseshoe or cut in half and rolled to secure the head and neck.
  - One to cover the patient if necessary, depending on the weather.
- A triangular bandage to secure the feet and ankles if appropriate.

Securing a patient

Once the patient's spine has been realigned to the neutral position, a hard cervical collar applied, if necessary, and the patient is scooped and positioned onto a well padded basket stretcher, movement of the patient's spine may need to be restricted. The following points are to be considered to safely restrict movement of the spine:

- The patient must be secured to the stretcher in such a way that it may be lifted, rotated, or even raised vertically without significant patient movement. For example, the patient should be adequately secured to the stretcher so that it can be rotated to facilitate drainage of blood or vomit, should the patient's airway become compromised.
- Spine boards are extremely uncomfortable even for a short period of time, so these devices should only be used for extracting an injured patient

from a difficult situation. By maximizing patient comfort, the patient is less likely to move or become agitated, thereby reducing the risk of further injury. If transport to hospital is prolonged (more than one hour) or over very difficult terrain, extra care must be taken to ensure maximum patient comfort.

- For the supine patient, padding should be placed in all body hollows and under all pressure points — i.e., the shoulder blades, sacrum, and heels. If the patient is in the lateral position, additional padding should be provided under the point of the hip (see Figure 48-9 Non-spinal lateral securing).
- The attendant must ensure that there are no hard objects such as keys, wallets, belts, etc. under the patient to cause discomfort or pressure sores. All securing buckles or knots should be padded so they do not press against the patient.
- Padding placed down the sides of the patient (see Figure 48-8a Rolled blankets placed around patient) aid in controlling lateral motion.

Figure 48-8a Rolled blankets placed around patient

- If the patient's head must be secured, the head and neck must be secured last. The head and neck must be maintained in the anatomical position manually, or with appropriate materials, while the rest of the packaging is applied (see page 31).
- The patient will have to be secured to the stretcher in order to restrict spinal movement. Velcro straps, spider straps, safety-belt type straps, or triangular bandages may be used.
- All strapping should cross over the midline anteriorly to allow rapid access to the patient for further assessment. If Velcro straps are used it is recommended that the straps overlap one another at least 25 to 30 cm (10 to 12 in.) to ensure solid contact. It is important for the patient's comfort that the Velcro be applied with the fuzzy side toward the patient. When the straps are pulled through the slots in the stretcher, they should be twisted 180 degrees, pulled snug, and applied to themselves, fuzzy side to hooked side. The ties should provide security without constriction and they should not cause pain.
- One or two chest straps should cross the front of the chest but should not restrict breathing. One or two straps are applied to cross the patient's pelvis. The securing ties should be high enough on the chest to allow the patient to breathe with minimal restriction and low enough on the abdomen not to cause discomfort. The attendant must remember that the objective is to comfortably restrict motion of the patient's spine. The position of the securing ties may have to be altered because of injuries (see Figure 48-8b Patient secured in basket).

Figure 48-8b Patient secured in basket

- The legs should be tied together in extension with padding (e.g., blankets or jacket) inserted between them and secured with two straps and a tie at the ankles.
- Once the patient's body has been secured in the appropriate position, the patient's head and the neck are secured by applying rolled blankets or other suitable compressible materials on either side of their head. If the patient's head must be secured, it must be secured in the stretcher last. This is best accomplished with a Velcro strap across their forehead and around the stretcher. A triangular bandage or tape may also be used. If the tape is used in cold or wet conditions, it may not stick to the stretcher. A dressing should be used to pad between the strap and the patient's forehead. The attendant should ensure that the patient's head is secured in a manner that does not risk rotation of the patient's head and neck.
- Securing ties should hold the patient's arms to their body rather than to the device, for ease of monitoring the pulse and in case intravenous therapy is needed.

- There must be sufficient padding placed under the patient. Extra padding is required in back of the patient, in front of the patient's pelvis and thighs, and in the hollow at the waist.
- A situation may arise in which the attendant must delegate some critical interventions — e.g., assisted ventilation with a pocket mask — to previously trained assistants. In such cases, it is imperative that the attendant frequently recheck the effectiveness of the treatment rendered by the helper and not become so distracted with packaging or other activities that the patient's condition deteriorates without the attendant's knowledge and the appropriate intervention.
- The attendant may have to delegate the packaging procedures to others while attending to critical interventions — e.g., airway management, assisted ventilation, control of major hemorrhage. In this instance, the attendant would supervise others from the head and then check all the strapping and padding once the critical interventions have been concluded.
- The patient must be kept warm. Cover the patient with blankets and keep the interior of the transport vehicle or ambulance warm. Spinal-cord injury patients are at risk for hypothermia.
- Patients require ongoing monitoring which includes reassessment of the ABCs:
  - Every five minutes for RTC patients
  - Every 10 minutes for non-RTC patients
  - Every 5 minutes for the urban attendant with a patient requiring stretcher transport
- Vital signs assessed and recorded:
  - Every 10 minutes for RTC patients
  - Every 30 minutes for non-RTC patients
  - Every 10 minutes for the urban attendant with a patient requiring stretcher transport

Reassessment of the head-to-toe examination every 30 minutes, particularly the head and neurological examination if there has been head injury, the chest, and the abdomen, as well as any significant injury site.

- The attendant must remember that patients with spinal-cord injury are especially prone to pressure sores. Patients with spinal-cord injury must be turned slightly every two hours to prevent pressure sores. The securing straps are loosened and the patient is log-rolled slightly from the supine position to one side and supported with a few inches of padding. If transport is occurring over rough roads, the vehicle will have to pull over for this procedure.
- The next time, the patient is rolled in the other direction to the opposite side and supported again with padding. The attendant should massage the skin areas over the body's bony prominences, such as shoulder blades, sacrum, heels, and elbows, after each rotation.

Basket stretcher

There are various types of basket stretchers, made of metal or fibreglass. These points are relevant to all of them.

- Padding/blankets should be placed under the patient for comfort (see Figure 48-9 Non-spinal lateral securing).
- A scoop stretcher at the bottom makes loading and unloading easier but should be removed if possible whenever the transport time is over an hour.
- The basket stretcher will accommodate the scoop.
- The patient must be secured if the stretcher is to be carried over a long distance or uneven ground.

Figure 48-9 Non-spinal lateral securing

Helicopter stretcher

The helicopter stretcher is a flat, aluminium spine board. The helicopter is equipped with one of these stretchers and the pilot usually knows how to use it. The helicopter stretcher is hinged in the middle and folds in half for easy storage. The attendant must ensure that the stretcher is opened and laid with the correct surface up, so it will not accidentally fold in half during use. If the attendant is unsure if the company stretcher will fit the helicopter or meet flight regulations, the pilot should be asked to bring a helicopter stretcher. The scoop or basket stretcher may be secured on top of the helicopter stretcher.

Multi-level stretcher

The multi-level stretcher weighs approximately 30 kg (60 lb.) and has an elevating head. The stretcher can be raised or lowered using the end or side release. When raising or lowering the stretcher, listen for a click indicating that the release is in place.

The stretcher has two safety bars (D bars) and should have straps to secure the patient. The stretcher must never be lifted by the D bars. The stretcher has a footrest to keep the patient from sliding off. The footrest may be placed upright and the covers wrapped over the handle to remove pressure from the patient's feet.

The multi-level stretcher has a few disadvantages. It is very unstable when fully extended because of its high centre of gravity, so it may tip over, especially if all the wheels are facing in one direction.

Carrying the multi-level stretcher

The multi-level stretcher is most suitable for use on smooth surfaces:

- Wheeling a stretcher when it is set low can cause back problems for the attendant, so it should be raised to a comfortable height and lowered only when it must be carried across rough ground.
- Reduce patient discomfort by making turns slowly and lifting the stretcher over obstacles.
- When carrying the stretcher on an incline, always carry it so that the patient's head is higher than their feet. Instruct the patient to keep their head on the pillow, legs straight, and arms folded across the chest.
- When loading the stretcher into a vehicle, first lower the stretcher, then, keeping your back straight, lift with your legs (see Figure 48-10).
- Never lift with the backrest, footrest, or D bars.

Figure 48-10 Loading a patient into the ambulance

When unloading the multi-level stretcher, lower it to the ground before extending the undercarriage. Most multi-level stretchers can be positioned so that the patient is semi-sitting, or with their knees flexed. The attendant should take advantage of these features if the patient's injuries permit.

Lifting and loading a carrying device

When lifting a patient on a stretcher, the attendant uses the same body mechanics as previously outlined. The objective of each lift is to complete it as safely and as efficiently as possible.

When a stretcher is carried to and loaded into a transport vehicle, the attendant should follow these guidelines:

- Use proper lifting techniques. Use enough helpers.
- Carry the patient feet first. This way, if the stretcher bumps into anything, the patient's head won't take the force of the blow.
- Carry the patient feet first down stairs or steep inclines as well. This keeps the abdominal organs away from the diaphragm.
- When the stretcher is placed in the ambulance, the patient's head should be at the front (see Figure 48-11).
- Never run with a stretcher. A quick, orderly walk accomplishes the same objective without adding the danger of tripping and falling.
- Ensure that the appropriate securing devices are in place.
- Use additional padding under a basket stretcher if the road is going to be rough. A piece of foam 15 cm (6 in.) thick, the size of the stretcher, may be used. Secure the stretcher to the transport vehicle to ensure that it doesn't move during transport.

Figure 48-11 Stretcher placement in ambulance

Summary

Patient lifts and carries are skills learned and perfected through training and practice. The only way an attendant can be sure of using the best technique for a specific situation is to continually practice the skills outlined in this section.

The attendant should remember that there is never an excuse for a patient falling off a stretcher. Only negligence allows this to happen.

Multiple casualties, disaster, and triage

The ultimate challenge to the attendant is an incident or disaster involving multiple casualties. Such a situation requires maximal use of all the attendant's skills and judgment, often in a setting of mass panic and ongoing hazards.

A disaster situation may be defined as any emergency that overwhelms the available medical resources. A disaster cannot be defined simply by the number of injured. Treating two injured patients in a wilderness setting can be much more challenging than treating 10 patients in a multi-vehicle incident with a multitude of bystanders, police officers, firefighters, and ambulance attendants available.

There is no substitute for emergency response and disaster planning. Forming a rescue team among co-workers and practicing periodically will ensure that when an emergency arises, the team will be fully prepared.

Disaster response

The attendant's first responsibility is to call for help. No one can handle such a situation alone. The attendant must call for the rescue team and get help from other workers or bystanders.

It should be apparent from the nature of the disaster whether or not transport to hospital will be required.

Usually, transport to hospital is required. The attendant must call early for emergency assistance when multiple casualties are involved.

When calling for emergency assistance, the attendant must be able to provide the dispatcher with as much of the following information as possible:

- Location of the disaster:
  - Exact address
  - Specific location at that address, especially if it is a large workplace or multi-storey building
  - GPS coordinates and/or useful landmarks if in a rural or wilderness setting
- Attendant's telephone number, enabling the BCEHS dispatcher to call back if further information
- is required
- Type of incident or disaster
- Estimated number of patients — the attendant should make a precise count of patients as soon as possible
- Estimated type and extent of injuries as soon as can be determined
- Hazards at the scene:
  - Fire
  - Downed wires
  - Hazardous materials (e.g., chemicals, explosives)
  - Landslide, avalanche, unstable debris
- Access to the scene:
  - Whether the road is open or blocked by the incident
  - Remote area (e.g., accessible only by helicopter)
  - Water access only
- Special situations:
  - Boating incidents (e.g., divers required?)
  - Severe weather conditions
  - Special extrication equipment required

On the basis of the information initially provided, the BCEHS dispatcher will be able to determine the number of ambulances needed and the need for other services (e.g., firefighters, police, coast guard). If the attendant can provide only limited information, delay in mobilizing the appropriate personnel and equipment will occur. It is better for the attendant to overestimate the number of patients and extent of injuries rather than to come up short-handed on vehicles and personnel.

The attendant and other rescuers must not rush blindly into a hazardous environment to extract and treat people. It is important to remember that dead or injured heroes cannot save lives. Be careful.

When faced with multiple patients in a disaster situation, the attendant must prioritize the patients for treatment and transport, determining which patients are critically ill and require rapid transport to hospital. The process of sorting out and prioritizing patients is called triage.

The first rule of triage is to do the greatest good for the greatest number. Sorting and prioritizing injuries and allocating the limited resources requires skill, judgment, and experience. The attendant must initiate a triage process, but responsibility for triage should be handed over to a more experienced person as soon as possible. That person may be an ambulance paramedic or, ideally, a physician.

At the same time, the attendant must select an appropriate triage area where patients can be safely assessed, treated, and transported.

The triage area must be established using the following guidelines:

- The triage area should be large, well-lit, and
- preferably protected from the environment.
- The triage area should be located at a safe distance from any known hazards.
- The triage area should be situated so that the entire disaster site can be seen from it.
- The triage area should be located between the incident scene and the evacuation vehicles so that orderly patient flow — from triage to assessment, to treatment and transport — can be maintained. The attendant should not take more than 10 seconds to choose the triage area.

The attendant must delegate one or two assistants to bring all necessary medical supplies, equipment, stretchers, etc. to the triage area. Once the area has been selected and assistants delegated to obtain all necessary equipment, the attendant initiates the triage process.

Triage of patients

The following rules of triage apply:

- Only immediately life-threatening conditions (e.g., airway obstruction, distressed breathing, major external hemorrhage) are identified and treated in the initial triage round
- Salvage of life takes precedence over salvage of limbs

Sorting

By using simple triage and rapid treatment (START, see Figure 49-1), patients are sorted based on objective criteria on how they present. The severity of injury and therefore treatment and/or transport priority in START triage is sorted by colour code. Triage tags contain these colours so treatment and transport crews can see at a glance which patients have been triaged to which level.

Colour Codes

- Green — minor injury — walking wounded
- Yellow — delayed — can wait
- Red — immediate
- Black — expectant or deceased

During the initial triage process, the attendant must survey all the patients as quickly as possible to determine the number of patients and to obtain an overall evaluation of the disaster scene. Therefore, the attendant, as triage officer, starts right away by giving clear, audible instructions to those injured: "Anyone who can hear me and can walk, please get up and come to me now." Those patients who can follow this simple direction are immediately categorized as "minor." Because these patients are able to move, understand simple directions, and do not appear to have life-threatening injuries, classifying them as Minor is appropriate. Apply a green triage tag to these Minor patients and direct them to assemble and wait nearby. This allows for a subsequent reassessment and provides a personnel pool for the attendant to use in assisting, as directed, more severely injured patients.

Using the primary survey and the rapid transport criteria, the attendant moves rapidly from one patient to another, identifying those who require immediate treatment, pausing only to treat life-threatening conditions, and prioritizing patients for transport to hospital (see Figure 49-1). Start triage assessments should not take more than two minutes per patient. Assistants are delegated to provide first aid.

The attendant should use the acronym RPM when assessing triage patients:

- R = respiratory
- P = perfusion
- M = mental Status

The first priority is to check for the presence of breathing.

Respirations:

- Breathing absent — patient unresponsive?
  - Open the unresponsive patient's airway. Is patient now breathing normally? Tag RED, immediate.
  - Patient's airway is open but patient is still not breathing normally or with only occasional gasping breaths.
    Tag BLACK, expectant or deceased.

- Breathing present? Assess adequacy of breathing.
  - Not breathing adequately?
    Tag RED, immediate.
  - Yes, breathing adequately?
    Assess perfusion criteria.

Perfusion:

- Radial Pulses?
  - Absent radial pulses?
    Tag RED, immediate.
  - Present radial pulses?
    Assess mental status

Mental Status:

- Follows simple commands?
  - Unable (unconscious or altered mental status)?
    Tag RED, immediate
  - Able (follows simple commands)?
    Tag YELLOW delayed.

The attendant should only attempt to correct airway problems or uncontrolled bleeding for red-tagged patients before moving on to the next patient. The attendant may be able to use the walking wounded who appear capable of assisting. Some of these walking wounded may be capable of assisting by maintaining head position to keep an airway open or keep direct pressure on a large wound. In this initial round of triage, patients who are obviously dead or who are in cardiac arrest are tagged black (expectant) and the attendant should focus on those patients who have life-threatening but salvageable conditions. Although this seems cruel and uncaring, in a disaster situation the attendant must do the greatest good for the greatest number of people. The limited personnel and resources must be directed to those patients who can be saved. The chance of survival for someone who has had a traumatic cardiac arrest is very small. Unless all the other patients have very low-priority injuries, the person in cardiac arrest must be bypassed. When all patients have been triaged, more focused treatment can start. Moving patients to treatment areas may be needed. Those tagged red or immediate are treated first, or moved to treatment areas, followed by those tagged yellow or delayed. Patients tagged black can be left in place.

Data collection and record keeping

If possible, one person at the scene should be assigned the task of identifying and recording the names of all patients. Equally important is an attempt to determine if there are any undiscovered patients. Some patients may be trapped; others may have run from the incident scene in a state of shock or panic. Some patients may have been transported to hospital by other witnesses, unbeknownst to the attendant.

In most disaster situations involving experienced personnel, a tag identification system is attached to each patient, outlining patient information as well as medical history, physical examination, treatment provided, and priority status.

Priorities for evacuation of multiple casualties

By the time patients are extricated, assessed, prioritized, and treated, the first ambulances have usually arrived, and assistance is available. In most mass-casualty situations, there are sufficient vehicles to maintain a steady flow of evacuated patients.

Generally, those patients with the highest priority, who are stabilized first, are evacuated first. In certain instances, there may be room for only one patient at a time in the transport vehicle. The highest-priority patient must be evacuated first. In other situations, where there may be room for multiple patients, it is best to evacuate one high-priority patient with one or two low-priority — walking wounded patients. Each situation differs significantly and the optimal solution is best determined at the scene, taking all factors into account.

All patients, but especially those tagged RED or YELLOW, must not be evacuated unattended. Depending on the complexity of the injury and ongoing requirements for treatment, the best-qualified individual must go with the patients. Patients with minor injuries who require little or no treatment may be evacuated with almost anybody who is available. High-priority patients who require constant attention, to their airway for example, will require a qualified person to attend them en route to hospital. Once again, the optimal choice should be made at the scene, taking into account the needs of the patient to be evacuated, as well as the needs of those patients awaiting transport.

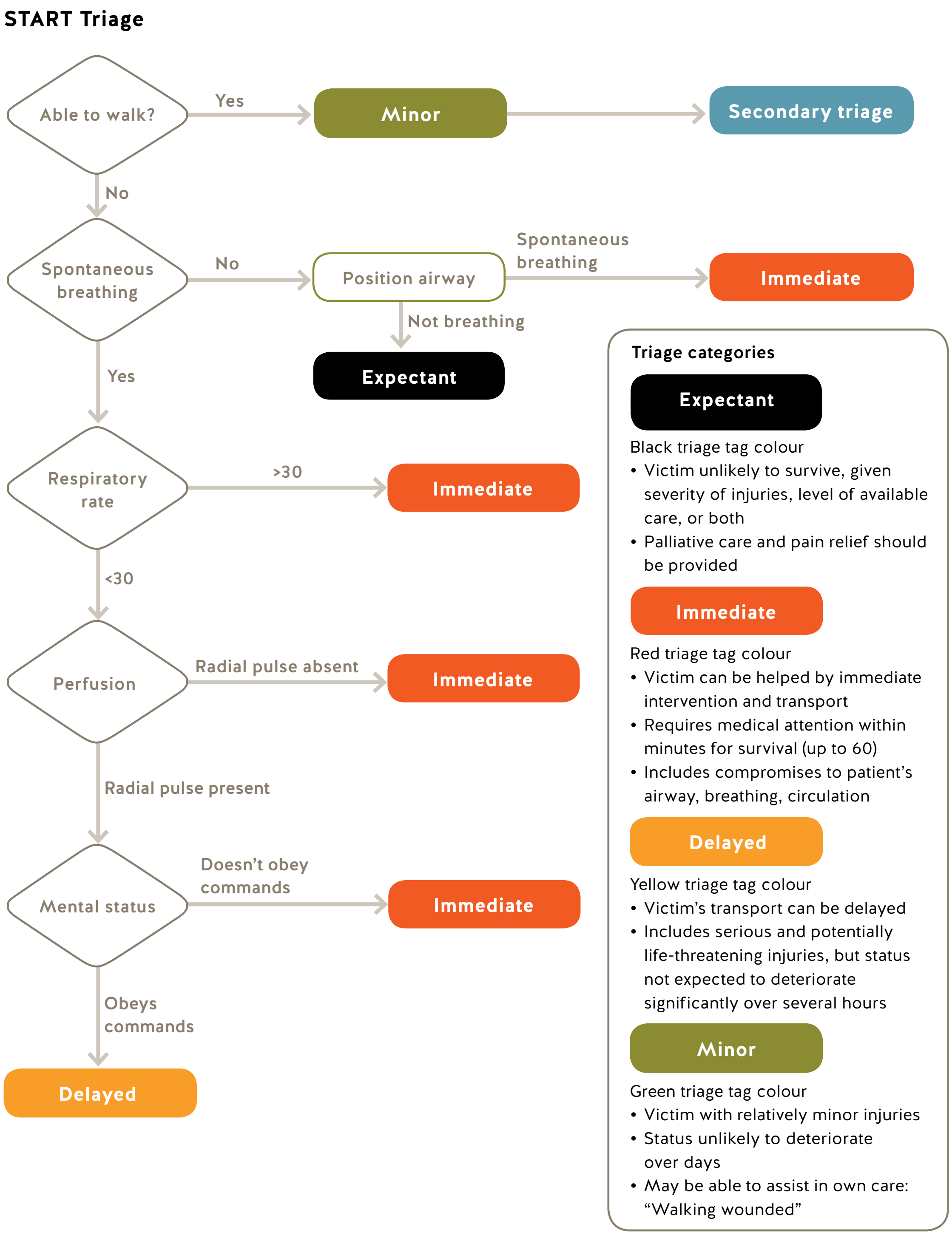


Figure 49-1 START triage

Finally, as each vehicle leaves the disaster scene, the dispatcher must be notified of the number of patients en route, the extent of their injuries, and an estimated time of arrival. It is also important that the dispatcher be asked to notify the hospital with all the pertinent information.

Summary

Multiple casualties in a disaster situation demand a triage approach to assessment and management. Above all, the attendant must try to take command of the situation with as much self-assurance and efficiency as possible. At the same time, the attendant must recognize their own limitations.

Transportation

The attendant's responsibilities are not necessarily completed after patient assessment and first aid treatment have been provided at the scene. Preparing the patient for transport and ensuring optimal transportation to the hospital is also the attendant's responsibility.

As the attendant is usually the employer's representative, they are usually responsible for ensuring compliance with the local first aid regulations. The attendant must prepare for any emergency beforehand and should practice running emergency response drills that follow the workplace emergency response procedures with all helpers. If there are other workers at the workplace who are trained in first aid, the attendant should include them in the practice drills. attendants must learn the existing procedures for transporting injured workers, preferably before the need to use them arises. The attendant may have to recommend changes or institute new procedures as necessary. As job sites differ, no one transport protocol can be devised that would be applicable in all situations. Written procedures for the evacuation of injured workers must be developed for each workplace.

Transporting injured workers

Procedures for transporting injured workers must address all of the following concerns and needs:

- Type of terrain over which the patient must
- be transported
- Location of the patient
- Distance to the nearest hospital and surface travel time
- Availability of an industrial ambulance or other properly equipped transport vehicle
- Response time to the workplace by BCEHS resources or the local ambulance service
- Maintenance procedures and equipment needs for the ambulance or transport vehicle
- Equipment and personnel requirements to assist with patient transport
- Special needs for remote workplaces, for example, helicopters, fixed-wing aircraft, or marine vessels may be required for patient transportation
- Communication with BCEHS or local ambulance dispatch, hospital, and other transportation agencies
- Backup procedures in case of equipment failure or adverse weather conditions

It is usually impossible to predict all the different types of problems that can arise when transporting patients, especially from remote workplaces. Conducting practice emergency response drills at different locations on the job site is the best way to evaluate the transportation procedures.

Industrial ambulances and emergency transportation vehicles

Some industries are required to have an emergency transportation vehicle (ETV) at the workplace. Other industries may maintain an industrial ambulance at a location central to their various workplaces. If the surface travel time from the workplace to the hospital is greater than 20 minutes, consideration should be given to maintaining an ETV. In some areas, BCEHS ambulance service response times may differ significantly for day, evening, night, and weekend calls. It may be necessary to develop different transportation procedures for emergencies when BCEHS ambulance personnel are on call.

The following guidelines are recommended for selecting and equipping an industrial ambulance or ETV:

- An industrial ambulance should have a patient compartment that can accommodate two patients on stretchers (see Figure 50-1). An ETV should be able to accommodate one patient on a stretcher.
- The attendant should be able to communicate directly with the driver. Direct access between the driver and patient compartment is desirable.
- The patient compartment should be large enough to provide sufficient room for an attendant to perform CPR.
- There should be sufficient space at the head of the patient for an attendant to assist ventilation and maintain the patient's airway.
- There should be no protrusions between the stretchers or over the head and chest of either stretcher patient.

Figure 50-1 Industrial ambulance

- The stretcher must have a means of safely securing it in the passenger/patient compartment of the ETV.
- The patient compartment must be well-lit, heated if necessary, and easily cleaned.
- All equipment necessary for patient care during transport must be permanently installed, secured, or stored in cabinets. On rough roads, unsecured items can become dangerous.
- All resource roads are “radio assisted.” The vehicle should be equipped with two-way radio communication between the attendant and the job site. Drivers must call kilometres, as posted/required. It is also desirable to be able to communicate directly with BCEHS ambulance dispatch and the hospital from the vehicle with another communication device. Resource road radio channels are for traffic management purposes only. Conduct all other communication on a non-resource radio channel when not travelling on a resource road.
- The chassis must provide optimal riding performance. Adequate road clearance or four-wheel drive may be necessary in certain locations.

The attendant should also ensure that the industrial ambulance or ETV is always in good working order. The vehicle and its equipment must be checked on a regular basis. The attendant is required to conduct a visual and auditory inspection of certain vehicle components before setting out, preferably at the beginning of their shift and following a call. At minimum, the inspection must include the brakes, steering, lights and reflectors, tires, horn, windshield wipers, mirrors, coupling devices, wheels and rims, emergency equipment and load security devices — stretcher and patient. Where a defect is discovered, the driver of the vehicle must inform and submit a copy of the inspection report to the owner or operator without delay. The vehicle owner or operator is responsible for management of pre- and post-trip inspections and maintenance.

Operations and transportation guidelines

Throughout their training, attendants receive guidelines to assist them in transportation decisions. Whenever a patient is in the rapid transport category, the attendant must follow these guidelines:

- Attendant must be mindful of the human factors associated with responding to a workplace first aid emergency. The attendant must control their emotions to provide the best care for the injured patient. The initial adrenalin rush and urge to get the patient to the hospital quickly may negatively influence prudent judgment. The attendant and the driver should communicate and acknowledge that the transportation vehicle must be operated in a safe manner at all times, obeying local traffic laws, to ensure the safety and comfort of all passengers.
- For industrial ambulances, the attendant must ensure that the driver is properly licensed to operate the vehicle. This should be done prior to an emergency arising. If the attendant has any doubts about the operation of emergency vehicles, they should contact the local law enforcement agencies or the Motor Vehicle Branch for direction.

Patient checklist prior to transport

1. Position the patient appropriately. The attendant must think ahead and anticipate problems.
2. People are more susceptible to motion sickness when they are injured or ill. Being secured to a stretcher for a long, bumpy, or twisting ride increases the risk of the patient vomiting. The attendant must anticipate the problem and position the patient accordingly. The patient should be transported with their head toward the direction of travel. There are several options when positioning a patient on a stretcher for transport. The decision will depend on the mechanism and anatomy of injury and the findings in the primary survey. The attendant could do the following
   - Ensure that the multi-system or head and/or spinal-injured trauma patient is secured supine adequately to a well-padded basket stretcher or another lifting device. The objective of securing this patient is to restrict spinal motion adequately

enough to allow the stretcher to be rotated, when necessary, to the lateral position, facing the attendant, while comfortably restricting spinal motion.

- Position and secure the patient in the lateral or ¾-prone position (see Figure 48-9 Non-spinal lateral securing), facing the attendant, after completion of patient assessment and treatment. Place the patient on the stretcher or cot in a position of comfort and secure with straps and/or seatbelts — e.g., supported semi sitting (see Figure 50-2). The best choice is left to the attendant's judgment, taking into account the needs of the patient, the length and difficulty of transport, and the availability of equipment and assistance.

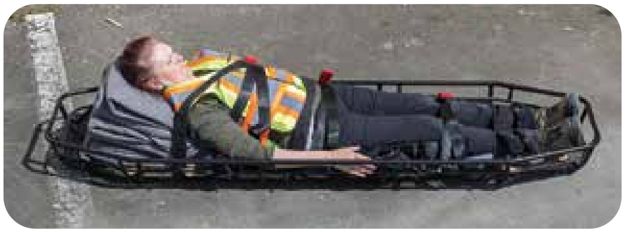


Figure 50-2 Supported semi-sitting in stretcher

3. Maximize patient comfort. For long transports, especially over difficult terrain, the patient must be adequately secured. The attendant should remember that a hard spine board is veryuncomfortable and should not be used for transport. A spine board should only be used to extract a patient from a difficult situation. Extra effort should be made to pad the board before securing and then, once extracted, remove the patient from the spine board onto a well-padded basket stretcher or cot for transport. Before the patient is secured for transport, bunched-up clothing, belts, and objects in their pockets should be removed. The patient with spinal-cord injury is particularly at risk for developing pressure sores. If necessary, pre-heat the vehicle to keep the patient warm.
4. Extremity injuries must be collectively immobilized to reduce pain and prevent further injury if the patient is to be subjected to a long and rough transport. Even if the patient is in the rapid transport category, extremity injuries must be effectively secured. On the other hand, only limited immobilization may be necessary for rapid transport category patients if the transport time is short or the ride is relatively smooth. All splints, bandages, and stretcher-securing straps must be checked before transport.
5. The attendant must check the equipment and ensure there are sufficient first aid supplies All basic life support equipment must be available and in good working order — e.g., oxygen therapy units, suction device AED. All equipment should be permanently labelled so it can be easily retrieved from the hospital, the BCEHS or workplace ambulance service.
6. Remember to bring along the patient's medications, if possible. If poisoning is suspected, it is important to bring along the container and the SDS to assist the physician in treating the patient.
7. Repeatedly assess and record the patient's vital signs at intervals appropriate in the circumstances. These will serve as the baseline for monitoring purposes en route.
8. Reassure the patient. Explain what procedures are to be done. Tell the patient where and how they will be transported. Even if the patient has a decreased level of consciousness, it is always important to explain things. Patients with a decreased level of consciousness can often hear or understand what is happening.
9. The attendant must direct the driver. A slower, smoother ride may be required, depending on the patient's condition.
10. The attendant must enforce the no-smoking rule inside the vehicle. Passengers, assistants, and the driver must all comply.
11. If communication is available, contact the BCEHS ambulance dispatcher to provide an update on the patient's condition and the estimated time of arrival. If the patient is being transported directly to a hospital, contact the hospital — usually the emergency department. It is very important to report any changes in the patient's condition, especially if there has been deterioration.
12. The attendant must bring along the patient Assessment chart. An extra pad may be useful to record the vital signs en route if there is insufficient space on the chart.
13. The patient's personal effects should be brought along on the transport. During the initial assessment

and treatment, it may be necessary to remove items such as watches, wallets, and rings. It is best to ask an assistant to hold on to them initially. The attendant must remember to bring or send them along with the patient to the hospital. In transit, the attendant should show the patient where their personal effects are located or at least talk to the patient about them.

Patient checklist during transport

En route to the hospital, the attendant must monitor the patient for any changes in their clinical status and, if necessary, treat the patient accordingly. It is important to recognize that the patient's condition may vary with time after injury. Some effects of injury may be delayed in onset and not be apparent initially. These injuries may only manifest themselves during transport and the attendant must be ever alert to recognize them.

1. Monitor the patient's ABCs, paying careful attention to the airway and the risk of vomiting during transport. If the supine patient retches or vomits, they must be rolled to the lateral position to prevent aspiration. The airway must be kept clear. Drainage by gravity may not be sufficient and the attendant must clear the airway using a finger sweep or suction device, if available.
2. Monitor the patient's vital signs. Worsening vital signs may represent deterioration of a recognized injury or the presentation of a previously unsuspected injury. For example, a decrease in the strength of the patient's pulses probably indicates the development of hypotension and shock from blood loss. If the attendant has already suspected an intra-abdominal injury with internal bleeding, the changes in the patient's vital signs probably represent deterioration in the recognized intra-abdominal injury. On the other hand, if internal bleeding was not previously suspected by the attendant, the changes in the vital signs likely indicate the delayed presentation of an unsuspected injury causing blood loss. The most common causes of internal bleeding are injuries of the chest and abdomen and pelvic fractures. Every 10 minutes reassess and record the vital signs of all patients who are in the rapid transport category. Every 30 minutes reassess and record the vital signs of all other patients. However, if there are any concerns about the patient's condition, the attendant should reassess more frequently and ensure that the BCEHS dispatch centre is updated.
3. If the patient's condition deteriorates into cardiac arrest, ask the driver to pull the vehicle off the road safely and stop, and then initiate CPR/AED. Ask the driver to update BCEHS dispatch and to provide them with your exact location. Continue CPR/AED, if possible, ask for help to maintain ongoing chest compressions and ventilations in accordance with local protocol. Trauma patients who suffer cardiac arrest have a very small chance of survival.
4. After reassessing vitals, carefully reassess and re-examine known sites of injury. Check dressings and bandages for evidence of ongoing bleeding or impaired circulation. Reassess splints to ensure that there has been no significant change in position. The neurological and circulatory status of injured limbs must be monitored. In particular, patients with head, chest, or abdominal injuries must be closely re-examined to detect any changes. As part of patient monitoring, perform a limited physical examination, not only checking the injured areas but also looking for new evidence of injuries. This examination must be repeated every 30 minutes during transport. Patients in the rapid transport category may require more frequent reassessments, depending on the status of their vital signs. In general, the sicker the patient, the more frequent the reassessments.
5. Reassure the patient. Keep them as comfortable as possible.

Transfer of patient responsibility

When BCEHS resources arrive or the patient reaches the hospital, the attendant transfers patient responsibility to the ambulance paramedics or medical staff, respectively. The attendant will be requested to provide specific information about the patient.

Figure 50-3 Providing patient information to ambulance attendant

The patient assessment chart should be given to the person assuming patient responsibility. The attendant should provide the following information as succinctly as possible:

- The patient's name and age (if known)
- Chief complaints
- What happened — history of chief complaints
- Brief mention of injuries and treatments
- Vitals
- Medical history
- Medications
- Allergies
- Other comments (e.g., complications, new injuries, time of last set of vital signs, last findings on physical examination)

The ambulance paramedics or hospital medical staff may repeat all the attendant's questions to the patient. They may remove existing dressings and untie existing splints. Although this may appear detrimental to patient care and perhaps wasteful of precious minutes, it is usually required because the person assuming medical responsibility for the patient must perform a thorough patient assessment. If the attendant is concerned about these delays, they may politely ask the person in charge to explain.

The attendant should also ask if further assistance is required — e.g., in lifting or moving the patient or assisting with any treatment. In certain cases, the attendant may be asked to assist with the transport by BCEHS resources or the workplace ambulance service to the hospital.

After the transfer of care, the attendant should gather all of the equipment for the return trip. In many cases, equipment such as splints or stretchers may still be required and will travel on with the patient. Arrangements should be made to pick up these items later. This emphasizes why all of the attendant's first aid equipment must be properly labelled. It is easy for equipment to be lost when it becomes mixed up with that of BCEHS resources or the hospital.

Checklist after transport

On completion of the patient transport, the industrial ambulance or ETV must be cleaned and prepared for reuse. The attendant's responsibilities include the care and maintenance of the vehicle. Legislation strictly regulates the packaging and disposal of biological waste generated by patient care. Disposal procedures depend on whether the waste is classified as biohazardous or medical waste. Biohazardous waste, also called infectious waste (e.g., blood, bodily fluids, and human cell lines) is waste contaminated with potentially infectious agents or other materials that are deemed a threat to public health or the environment. The attendant must exercise special precautions in handling materials/objects that may be contaminated. Often these biological wastes are contaminated with germs or other micro-organisms that can cause illness. The attendant must follow the workplace exposure control procedures and safe work practices recommended by the employer. After every first aid call, the attendant should do the following:

- Replace or clean soiled linen.
- Clean or replace all equipment that was used for the patient.
- Refill all first aid supplies in the vehicle.
- Replace used oxygen therapy equipment.
- Wash the stretcher and floor or other areas of the ambulance as required.
- Refill the gas tank, and check the oil, coolant, and
- tires. Perform a post-trip inspection and ensure that any other maintenance checks that may be required are carried out.

Local ambulance service

In some parts of Canada, a variety of agencies may provide ambulance service. It is imperative that the workplace attendant know how to access the BCEHS and/or workplace ambulance service, understand its capabilities, and know its response time to the workplace.

BCEHS paramedics are specifically trained to handle major trauma patients, especially those in the rapid transport category. Most BCEHS paramedics — PCP, ACP, CCP — have specific protocols for instituting intravenous therapy on trauma patients. They can also provide effective pain medication, where indicated, for patients with painful fractures, dislocations, or soft-tissue injuries. Paramedics are also trained in the use of defibrillators for cardiac arrest patients. In some centres, advanced life support — ACP, CCP — vehicles staffed with paramedics are available to provide advanced cardiac life support — ACLS. In summary, BCEHS resources can provide the following:

- Equipment not available to or that is beyond the scope of practice, of the attendant — e.g., traction splint.
- Advanced pre-hospital care procedures that attendants are not trained to do, e.g., check blood glucose.
- Transport to hospital, especially for the urban attendant. Even if an industrial ambulance or other transport vehicle is available, it may be beneficial to have BCEHS resources rendezvous en route (see Figure 50-4). The patient may benefit from the transfer to a better-equipped vehicle with emergency lights and sirens and paramedics who may be able to provide more advanced pre- hospital care.
- Patient transfers from the helipad or airport to hospital, if necessary. Precious minutes may be lost waiting for an ambulance to arrive at the airport if early contact was not made.
- Help in mobilizing other agencies — e.g., police, fire fighters, coast guard, rescue personnel — if their assistance is required. Some ambulance dispatchers are also trained ambulance paramedics. They are also able to provide the attendant with advice regarding pre-hospital care.


Figure 50-4 Meeting ambulance service en route

The attendant must think ahead and anticipate the patient's needs. By rapidly accessing BCEHS resources where indicated, they will optimize the patient's care. All emergency health care workers are part of a team, each with the same purpose — the optimal care of the sick and injured. Cooperation between attendants and BCEHS personnel invariably results in faster and better care for the injured worker. The urban attendant will need the BC ambulance service to transport their patient to a place of medical treatment. In most urban centres, the BCEHS dispatcher will activate the local fire rescue service in addition the the BC ambulance service. In cases where the local fire rescue service arrives prior to the BC ambulance service, the urban attendant should cooperate with the local fire rescue service and, if necessary, assist them while waiting for the BC ambulance service to arrive.

Contacting BCEHS dispatch

It is always preferred that the attendant who is attending the patient contact ambulance dispatch directly rather than delegating this responsibility. In certain circumstances (e.g., with a critical patient or an inaccessible phone) the attendant may delegate the responsibility of contacting ambulance dispatch. Ideally, the delegate caller should stand close enough to be able to see, hear, and speak to the attendant and to transfer information and updates to BCEHS in real time. However, it is essential that all information listed in Table 50-1 be relayed to ambulance dispatch. Based on the information provided, BCEHS dispatch will determine the type of ambulance response and the level of pre-hospital care required. Inaccurate or missing information can result in an inappropriate or delayed response, which may adversely affect patient care.

Air evacuation

Medical air evacuation has become increasingly common over the past few years. During the NATO missions in both Afghanistan and Iraq, there was a dramatic decrease in morbidity and mortality in trauma patients because of the rapid transport to hospital using helicopters. In some regions, dedicated helicopters and medical personnel are specifically used as first responders for medical emergencies. In remote areas, air evacuation is often a necessity because of the terrain and distance to hospital. As with surface transports, responsibility for arranging and preparing for air evacuation is delegated to the attendant. Medical air evacuation presents special problems for the attendant.

Patient information required by ambulance dispatch

- Precise location of the patient including map and/or GPS coordinates
- Name, age and gender of the patient
- Mechanism of injury
- Patient's chief complaint(s)
- History of chief complaint (what happened)
- Vital signs
- Treatment rendered
- Special equipment or personnel needed
- Estimated time of arrival if an ETV or industrial ambulance is being used and a rendezvous is requested

Table 50-1

Physiological considerations of air evacuation

The medical effects of changes in altitude associated with an air evacuation can be profound. The following factors are important:

- Changes in barometric pressure
- Variation in the partial pressure of oxygen with altitude
- Effect of acceleration/deceleration and angle of climb/descent

Changes in barometric pressure

Air pressure decreases as the elevation above sea level increases. The laws of physics tell us that air-containing devices or organs will expand as the outside pressure decreases. During medical air evacuation, in an aircraft cabin that is not pressurized, the air inside an air splint, for example, will expand during ascent to cruising altitude. This will result in further constriction around the patient's splinted extremity and may cut off the patient's circulation. Similarly, a partially-filled glass IV bottle — or any other glass bottle — may explode as the air inside expands with ascent. For these reasons, air splints and glass containers are not recommended for aeromedical evacuations.

A patient with a pneumothorax may deteriorate significantly with ascent as a pneumothorax expands. Unless the aircraft is pressurized, the only option is to maintain as low a flight altitude as weather conditions and terrain permit.

The opposite effect occurs with a drop in altitude. During an air evacuation in mountainous terrain, the attendant must deal with multiple pressure changes as the pilot flies over a succession of mountain ranges.

Table 50-2 shows the expansion factor at different altitudes compared to sea level.

Any gas-containing organ may be affected. The most common example of the effect of change in barometric pressure is pain in the ears or sinuses. This occurs most often in an individual with a cold or sinusitis.

Important injuries where pressure effects are potentially dangerous include:

- Open head injuries
- Facial fractures, especially involving the sinuses
- Open eye injuries
- Pneumothorax
- Decompression illness
- Gas gangrene

There are only two ways to overcome the detrimental effects of gas expansion:

- Maintain the flight altitude as close to sea level as possible, terrain and weather permitting.
- Use a pressurized aircraft.

Expansion factors at different altitudes

Altitude	Expansion Factor
Sea Level	1.00
5,000 ft.	1.20
8,000 ft.	1.33
10,000 ft.	1.50

Table 50-2

Altitude limits for air evacuation of patients with specific conditions		
Altitude limit above sea level	**Cardiorespiratory disorders**	**Non-cardiorespiratory disorders**
2,000 ft.	• Suspected heart attack • Heart failure • Respiratory failure	• Decompression illness • Penetrating eye injury • Severe facial injury • Open skull fracture
4,000 ft.	• Pneumothorax	• Carbon monoxide poisoning • Bowel obstruction
6,000 ft.	• Shock	• Coma • Stroke • Seizures
8,000 ft.	• All other medical conditions necessitating aeromedical evacuation	

Table 50-3

Variation in the partial pressure of oxygen with altitude

The oxygen content of air decreases with altitude — the air is "thin" at high altitude. The level of oxygen in the circulating blood decreases dramatically with altitude.

Commercial jets, which cruise at altitudes of 9,144 metres (30,000 ft.) or more, are pressurized only to 2,438 metres (8,000 ft.). The oxygen level in a normal patient's blood is therefore less than normal at such heights. That is one reason why patients with severe respiratory disease or pregnant patients near term are not allowed to fly without a doctor's letter.

In critically ill patients, the dramatic drop in the level of blood oxygen can be life threatening. The effect is more profound in patients with hemorrhage, who also have a decreased blood volume.

The only remedies for hypoxia under these circumstances are pressurization of the aircraft and the provision of supplementary oxygen. For all patients who require an aeromedical evacuation via an unpressurized aircraft — helicopters are unpressurized — a strict altitude limit of 2,438 metres (8,000 ft.). is also mandatory. Altitude limits for specific conditions are shown in Table 50-3.

Keep oxygen saturations above 92% for flight — this may mean oxygen via nasal cannula at 2-3 litres per minute (L/min). There are some exceptions where oxygen is helpful, and exceptionally helpful at altitude. Provide oxygen, at a flow of 10 L/min to the following air evacuation patients:

- Pneumothorax, chest injuries
- Decompression illness
- Smoke inhalation or suspected carbon monoxide toxicity

Effect of acceleration/deceleration and angle of climb/descent

The G-forces experienced on takeoff and landing in fixed-wing aircraft can have detrimental effects on the air evacuation patient. The same forces that "drive you into the seat" on takeoff will cause redistribution of blood flow in the patient. For example, if the patient is lying down (supine or lateral) on takeoff, with their head forward, the forces will cause the redistribution of blood to the feet and away from the heart and the brain. This can have detrimental effects on patients with hemorrhagic shock, who have decreased blood volume.

Similarly, if the angle of climb is quite steep on takeoff, the blood flow is redistributed to the feet. It is the same effect as if the patient were standing upright.

The opposite effects occur on descent and landing. These effects are minimal for helicopter evacuation because the flight cabin is usually maintained near horizontal and the G-forces are usually directed vertically rather than horizontally. However, for fixed-wing aircraft, the attendant must take certain precautions to limit those effects. If possible, the attendant should notify the pilot if there is concern that aggressive flying will negatively impact the patient.

Depending on the position of the patient's head, the attendant may have to elevate the legs or stretcher to compensate for the effects of G-forces and the angle of climb. For example, if the patient is positioned feet forward, head back in the flight cabin, no adjustment is required for takeoff and ascent. In that case, the blood is redistributed to the heart and brain. However, on descent and landing, the legs or stretcher should be elevated approximately 15 cm (6 in.) to compensate.

Medical effects related to the flight environment

There are other effects on a patient in the flight cabin of an aircraft:

- Air sickness is relatively common during air evacuation. The following approaches help to manage it.
  - Administer oxygen as above.
  - If possible, have suction readily available and operational.
  - If no suction is available, the patient must
  - be transported in the lateral position unless the patient can be quickly and easily rolled as required.
  - Reassure the patient as much as possible.
- Noise, turbulence, and vibration make it difficult to hear and talk with the patient. Explain to the patient ahead of time that this may occur. For some patients, the noise and vibration is quite frightening and may make them agitated and anxious.
  - Splints, dressings, or other equipment may loosen
  - up or become undone. The attendant must secure all splints, dressings, and ties prior to takeoff.
  - All first aid equipment must be secured, especially oxygen cylinders. The use of glass containers or objects is best avoided. Plastic, unbreakable containers are best.
- Lighting is often poor and observing the patient may be difficult. Electrical supply may be variable and unreliable aboard an aircraft. The attendant must bring along a flashlight and extra batteries. Only battery-powered devices are recommended. Cabin temperature may also be a problem, especially with ascent to altitude. The attendant must take extra blankets to keep the patient warm.
- Space limitations in the cabin make any medical procedures or first aid treatment difficult to perform. All necessary first aid procedures are best performed on the ground prior to takeoff. The attendant must think ahead, anticipating problems, handling them on the ground

In summary, altitude effects and flight environment considerations are of special clinical importance in aeromedical evacuation. The attendant must consider these factors, especially in high-risk patients, when choosing between air evacuation and land transport. Furthermore, the attendant must take extra precautions when evacuating the patient by air to prevent disastrous complications en route.

The current procedures for evacuation of injured workers may be outdated or deficient. The responsibility for review may be delegated to the attendant. Policies and procedures for aeromedical evacuation at the workplace must deal with the following items and concerns:

- The need for an air evacuation
- Aircraft selection
- Pre-flight communication with the flight crew
- Pre-flight communication with BCEHS dispatch and hospital
- Checklist prior to aircraft arrival
- Safety procedures around helicopters and fixed-wing aircraft
- Pre-takeoff checklist
- In-flight patient monitoring
- Backup procedures in the event of equipment failure, unavailability of aircraft, or poor weather conditions

The need for medical air evacuation

Broad guidelines exist for determining the need for a medical air evacuation. If BCEHS is contacted, transportation decisions are made by provincial dispatch centre with the assistance of pilots, paramedics, and transport physicians.

Aeromedical evacuations do present some potential risks to the patient, as discussed previously. There is also the small risk of crashing, which increases in poor weather conditions. Finally, medical air evacuations are costly. Inappropriate use will, in the long run, create problems for both the employers and employees.

The following criteria are suggested for determining the need for medical air evacuation.

- Use air evacuation if land transport is impossible, unavailable, or will aggravate the patient's injuries because of roughness. In certain remote areas, the

only access may be by air. In other situations, the roads may be washed out or blocked, making land transport impossible.
- Use air evacuation if the patient is in the rapid transport category and total transport time by land to hospital exceeds total transport time by air by 30 minutes.

Patients whose illnesses or injuries place them in the rapid transport category must be transported to hospital as quickly as possible for definitive care.

When calculating total transport time for air evacuation, the attendant must factor in the time to find a helicopter or fixed-wing aircraft and the time it will take it to get to the incident site. Although air travel is inherently faster than land transport, it may take significantly longer to organize an air evacuation and then await the aircraft's arrival. In those circumstances, land transport may be advised. Conversely, it may take excessively long for a land ambulance to arrive; in such circumstances, air transport may be advised. It is best to use air transport for seriously injured patients if the total time saved is 30 minutes or more.

The decision to use air transport rests with the attendant, taking into account all the risks and benefits. In some parts of Canada, including B.C., if the workplace has not prearranged an air evacuation service and ensured that flying is possible before work begins each day, the decision to use air evacuation is made by a dispatcher or a physician. The decision will be based on the medical information provided by the attendant.

Aircraft selection

The aircraft selected for medical air evacuation must meet certain minimum criteria. The selection of an inappropriate aircraft will only delay the air evacuation, thereby losing precious time. The following are minimum criteria for evacuation aircraft.

- The aircraft must have a patient compartment large enough to accommodate the stretcher with the patient, the attendant, and all necessary equipment. There must be sufficient room for the attendant access all relevant parts of the patient's body. Do the seats have to be removed, or are they collapsible, to accommodate the stretcher?
- Is the aircraft capable of carrying the extra weight over the terrain and distance required?
- Does the aircraft, fully loaded, have sufficient range to make the trip with safety allowances?
- Is there sufficient space in the patient compartment to rotate the patient to the lateral position, or is suction available and the patient's head accessible? Otherwise, the patient will have to be positioned in the lateral position so they face the attendant in flight, prior to takeoff.
- The door to the patient compartment must be sufficiently wide to accommodate a fully packaged trauma patient in a stretcher or cot.
- If nighttime air evacuations are required, or where weather conditions are often poor, transport regulations may require two pilots, twin engines, and night flying capabilities. These special situations must be discussed with the aircraft companies and possibly the federal transportation authorities. Alternative evacuation procedures may be required.
- If fixed-wing aircraft are to be used, can the runway accommodate a fully loaded plane in all weather conditions?
- Radio communications with the hospital and/or ambulance dispatch are beneficial.
- The attendant must be able to communicate directly with the pilot.

Pre-flight communication with the flight crew

The attendant must contact the flight crew on a pre-arranged radio frequency and provide or request the following information:

- Provide the exact location and a description of the landing site (e.g., highway, field, dirt road). For fixed-wing aircraft, the length of the runway is also required — e.g., GPS coordinates and/or resource road grid co-ordinates are useful in some workplaces.
- Provide an update on weather conditions, including:
  - Cloud cover
  - Visibility — distance
  - Fog, snow, rain
  - Wind velocity and direction, if known
- Describe obstacles within half a mile on all sides of the landing area, including wires, towers, and mountain peaks.
- Explain what type of signal will indicate the landing area and important obstacles. Strobe lights are frequently used by first responders to mark landing sites; however, smoke canisters or flares may be preferred because the smoke also provides an estimate of ground wind velocity and direction.
- Offer an estimate of the time when darkness sets in at the landing site.

- Determine the ETA for the aircraft at the incident site.
- Ensure that the flight crew will bring along any additional equipment that may be required (e.g., a helicopter stretcher, #9 stretcher, basket, extra oxygen cylinders).

Pre-flight communication with BCEHS dispatch and hospital

The attendant must communicate, if necessary, with BCEHS dispatch to organize the patient transfer from the final destination to the hospital. If not, precious time will be lost awaiting the ambulance when the patient arrives at the destination.

It is also extremely important that the attendant inform the hospital of the patient's transfer, including an estimated time of arrival. Ask BCEHS Paramedics or the employer's dispatch to notify the hospital prior to take off. Proper hospital notification implies much more than simply leaving a message at the switchboard. It is best to discuss the case directly with the hospital emergency department. You may be talking to a nurse or to the physicians. Pertinent medical information and an estimated time of arrival must be provided so that the hospital will be adequately prepared. For example, physicians and nurses may have to be called in. By coordinating efforts closely with that of the hospital, the attendant prevents unnecessary treatment delays. Finally, hospital personnel may be able to advise the attendant about stabilization, treatment, and transport of the patient.

Checklist prior to aircraft arrival

- When possible, the landing site should be checked to remove all loose debris (see Figure 50-5).
- Where necessary, road blocks should be set up approximately one quarter mile on either side and ends of the landing area.
- Crowd control measures must be enforced. The attendant must ensure that everyone is at least 30 to 60 m (100 to 200 ft.) away from the helicopter landing site, to avoid injury from flying debris caused by rotor downwash.
- The attendant must ensure that the landing site is clearly marked with strobe lights, signal flares, or smoke canisters. The signal strobes, canisters, or flares should be away from the actual landing site (see Figure 50-6).
- Before the aircraft lands to pick up the patient, the attendant should do the following:
  - Brief all assistants on safety procedures, including instructions to wait for the pilot to signal that it's safe to approach.
  - Keep all assistants and the patient out of the way
  - at the side of the landing zone.
  - Ensure that each assistant knows what to do as soon as the pilot gives the signal to load the patient.

Figure 50-5 Keep the landing site free from loose debris

Figure 50-6 Keep landing signal well clear of the landing site

Safety procedures around helicopters and fixed-wing aircraft

It is important that the following safety procedures be followed around aircraft:

- For helicopters, the attendant may have to direct the pilot's approach and landing. The pilot may be unable to acknowledge instructions, even by radio (see Figure 50-7). Stand at the side of the landing site, with your back to the wind and arms outstretched forward, pointing to the landing site (see Figure 50-8).
- Do not approach the aircraft until the pilot indicates it is safe to do so. Usually the pilot will stop the blades prior to allowing people near the helicopter.

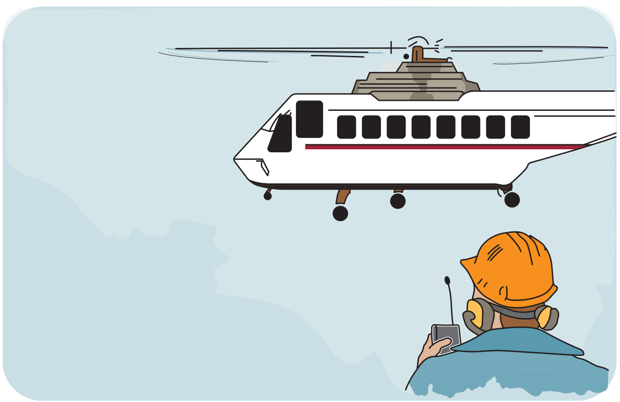


Figure 50-7 Directing the pilot by radio

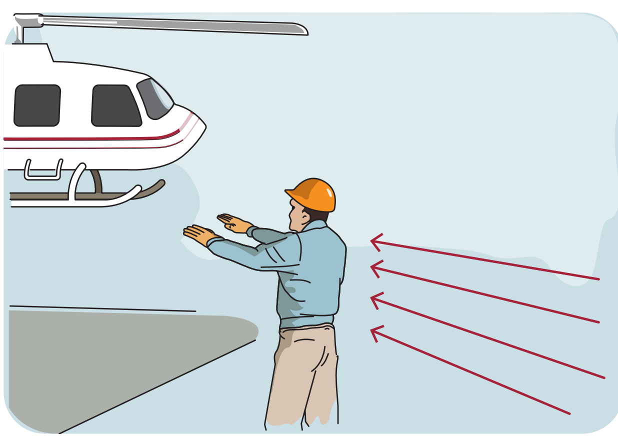


Figure 50-8 Directing the landing

- The attendant and all assistants must wear eye protection (face shields or goggles) during takeoff and landing (see Figure 50-9). Assistants should face away from the aircraft on landing and takeoff.

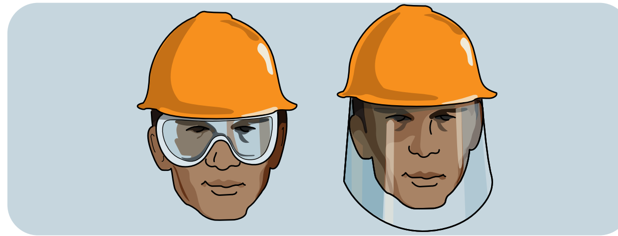


Figure 50-9 Wear eye protection

- Protect the patient from flying debris during an aircraft's landing.
- Always approach or leave helicopters from the front or side, within the pilot's field of vision (see Figure 50-10). Never approach or leave a helicopter from behind. On uneven terrain, it is always best to approach or leave a helicopter on the downslope side to avoid the main rotor (see Figure 50-11).

Figure 50-10 Approach or leave in the pilot's field of vision

Figure 50-11 Approach or leave on the downslope side

- The attendant and assistants should keep their arms close to their body and crouch when approaching or leaving a helicopter to ensure adequate clearance from the main rotor (see Figure 50-12).

Figure 50-12 Crouch when approaching or leaving the machine

- Remove or fasten loose clothing (e.g., hats, jackets) so they will not fly off or interfere with other assistants (see Figure 50-13).

Figure 50-13 Hold onto hard hats when approaching or leaving the machine

- Never touch the bubble or any of the moving parts of a helicopter such as the tail rotor or linkage (see Figure 50-14).

Figure 50-14 Do not touch the bubble or any of the moving parts

- Never carry anything above shoulder height when approaching or leaving a helicopter.
- The patient should not be carried or lifted above waist height when being carried to or from, or loaded into or out of a helicopter (see Figure 50-15).

Figure 50-15 Carry the patient waist high

- Fasten seat belts after entering a helicopter and leave them buckled until the pilot signals that it is safe to disembark.

Pre-takeoff checklist

This procedure is similar to the patient checklist prior to surface transport discussed previously:

- Instruct the pilot not to take off until the pre-takeoff checklist has been completed.
- Position and secure the patient appropriately.
- Maximize patient comfort.
- Check all splints, bandages, and dressings.
- Check and secure all equipment.
- Ensure that there is an adequate supply of oxygen.
- Remember to bring along the patient's medications, if possible. Bring along the patient's valuables and remember to show the patient where they are, or at least discuss this with the patient.
- Reassure the patient.
- Repeatedly assess and record the patient's vital signs and update BCEHS if there are any notable changes in the patient's condition.
- Confirm that the onboard radio is working. It is important that the attendant be able to communicate directly with the pilot at all times.
- Update the BCEHS dispatch and the hospital with the patient's status and a revised estimated time of arrival, if possible.
- Advise the pilot of any altitude limitations that may apply. For fixed-wing aircraft, the angle of climb may have to be reduced as well.

In-flight patient monitoring

Guidelines for in-flight patient monitoring are identical to those outlined in the patient checklist during transport on page 350.

Aeromedical evacuation can be truly life saving, provided that extra care is taken to avoid the pitfalls. The special physiological effects of air evacuation imply that the patient cannot be simply loaded into a plane or helicopter and taken away into the wild blue yonder. Because of all the intricacies involved in organizing and carrying out a proper air evacuation, it is essential that the attendant organize evacuation drills with the aircraft company, flight crews, and co-workers to evaluate and test the written policies and procedures in force at the workplace. Only by pre-planning, reviewing, and testing can the employer and the attendant ensure that safe and efficient aeromedical evacuations are available for injured workers.

Appendices

Appendices

Emergency childbirth and infant resuscitation

Miscarriages

A miscarriage is defined as the loss of the fetus or embryo at any time before the 20th week of pregnancy.

Signs and symptoms

- Vaginal bleeding, probably sudden and profuse
- Cramp-like pains in the lower abdominal or pelvic area
- Possible signs of shock
- Passage of the fetus and other material

Management

- Perform ABC interventions as necessary
- Reassure the patient
- Administer oxygen, if necessary
- Place a sanitary napkin or clean towel over the area
- Keep expelled material for medical aid, but out of sight of the patient

This patient is in the rapid transport category. The attendant may have a patient who goes into labour unexpectedly. Be calm. Do not be in a hurry to transport the patient.

Evaluate the situation:

- Is this the patient's first child? If so, labour usually takes 12 to 15 hours. The period of labour with subsequent children is much shorter.
- Listen to the mother and time the contractions.
- If labour has just begun and there are no signs of immediate birth, transfer the mother to the nearest hospital. She should be placed on her left side, as this relieves pressure on the aorta and vena cava and will ensure that the baby has a good blood supply.

Signs of immediate birth

- The mother is having contractions every two minutes or less.
- The mother says the baby is coming. Believe her.
- The baby's head is visible at the vaginal opening (crowning).
- The mother is straining and pushing down during contractions or feels she has to have a bowel movement.

Signs that may indicate that labour is not progressing normally are:

- Hemorrhaging — before, during, or after the birth.
- Weak contractions or contractions stop.
- Prolapsed cord or malpresentation (breech) hips with legs up or feet first — face presentation or baby lies transversely in uterus.
- Maternal distress — shock from loss of blood and dehydration from a long, difficult labour.
- Fetal distress — if the baby is deprived of oxygen while it is still in the uterus, it will pass meconium (feces) into the amniotic fluid. The meconium will stain the amniotic fluid yellow, green, or dark brown, depending on how much the baby passed.

Do not try to delay the delivery by any method. Keep calm and reassure the mother. Obtain medical help.

Emergency childbirth supplies

- 4 clean towels
- 2 folded sheets
- 1 receiving blanket for the baby
- Gauze squares
- Small rubber ear bulb syringe
- Isopropyl (rubbing) alcohol
- Sterilized scissors
- Sterilized ties or clamps — for umbilical cord
- Diapers
- Safety pins
- Basin or pan — in case the mother vomits
- Blanket for mother
- Sanitary napkins
- Plastic bag or container for the afterbirth
- Flashlight, if the trip is at night

Procedure to assist birth

Wash your hands. Get the supplies ready. Position the mother on her back, with her knees raised, feet flat, and thighs separated. Place clean towels or newspapers under her buttocks and a pillow under her head. If in a public place, provide for the mother's privacy. Talk to the mother about the procedures, to help put her at ease.

Stand by to assist the mother. Have her family member or friend stay at the mother's head to help reassure her and keep a constant check on her airway.

Be ready to support the infant and handle it very gently. Do not encourage pushing or bearing down as crowning progresses. Normally the infant will present face down. Have the mother take short breaths of air and blow out or pant, to slow delivery of the infant's head and lessen the damage to the mother's perineum.

In the event that the water bag has not yet broken, carefully tear the bag open with a finger at the back of the infant's head. Peel it away from their face.

Clean the infant's face, removing mucous and fluid from around their mouth and nose. Gently squeeze the infant's nose to get most of the mucous out. Using a bulb syringe, very carefully suction the infant's mouth and nose.

If the cord is around the infant's neck and is very loose, slip the cord over their head. If the cord is too tight and is choking the infant, use sterilized ties or clamps and tie the cord in two places, 5 cm (2 in.) apart, then cut between the ties, and remove the cord from their neck. Do not try to pull the infant out. Gently support them and, on the next contraction, instruct the mother to bear down. Be prepared to hold the infant. Caution: They will be very slippery.

Clear mucous away from the infant's mouth and nose.

Hold the baby's feet slightly elevated with their head down to help drain away fluids from the airway. Keep the infant warm.

If the infant does not start breathing within 30 seconds, resuscitation procedures must be initiated. The mother will rest between the next contractions.

It usually takes up to 20 minutes to expel the placenta. Wrap the placenta in a towel and take it to the hospital for a doctor to examine.

Check the mother's uterus for firmness by palpating the abdomen just below the navel. If it is not firm and there is excessive bleeding, gently massage this area until it feels hard and firm.

It is not necessary to cut the umbilical cord unless medical care cannot be obtained for several hours.

There is danger of infection through the open end of the cord if it is cut with unsterile equipment, so it is better to leave the cord uncut. However, it should be clamped or tied off while waiting for the placenta to be expelled. Caution: If the cord is not clamped or tied off,the placenta must be held above the infant to prevent them from hemorrhaging from it.

If the cord is to be cut, wait until pulsations in the cord stop — roughly five minutes. Use strips of sterile cloth if no clamps are available. Tie one strip at 10 cm (4 in.) and another at 15 cm (6 in.) from the infant's body. Cut through the umbilical cord between the ties with sterile scissors or a sterile razor blade. Caution: Make sure the ties are secure and there is no bleeding from the cut ends. Put on another tie close to the original tie if there is bleeding. Wrap the infant in a warm blanket and give them to the mother to hold, as her body will keep the infant warm. Re-check for bleeding from the cord.

Clean the area around the vagina, and then place a sanitary napkin or clean cloth over the area. Some bleeding is normal. Cover the mother with a warm blanket and transport her to a hospital. Periodically monitor the firmness and size of the mother's uterus by palpating the abdomen as previously described.

Child and infant resuscitation

For the purposes of resuscitation and obstructed airway management, the following age definitions apply:

Infant — one year of age or less

Child — one to eight years of age

Adult — eight years of age or more

Child resuscitation

Child resuscitation is similar as for an adult but with less force required to compress the chest. Position one or two hands in the centre of the chest and give 30 chest compressions. Compress the chest at least a third the depth of the chest, or about 5 cm (2 in.), at a rate of at least 100 chest compressions per minute. Attach and use an AED as soon as one is available. If you are alone, provide two minutes of CPR before leaving to activate EMS.

Infant resuscitation

Assess responsiveness by calling out to the infant and gently tapping the feet. Send for medical aid. Open the airway using a head-tilt chin-lift. Check for signs of breathing. If the infant is not breathing normally or is taking only occasional gasping breaths, begin CPR. Position two fingers in the centre of the chest just below the nipple line and give 30 compressions.

Compress the chest at least one third of its depth, or 4 cm (1½ in.), at a rate of 100 to 120 chest compressions per minute. Open the airway and cover the mouth and nose with your mouth or a face mask and give two breaths using just enough air to make the chest rise. Take one second to deliver each breath.

Perform cycles of 30 chest compressions to two ventilations. Attach and use an AED as soon as one is available. If alone, provide two minutes of CPR before activating EMS.

Choking infant or child

In infants and children, choking is commonly caused by the unexpected lodging of small objects (e.g., beads, marbles) or food (e.g., peanuts, candies) in the airway. Choking may also be caused by infection or allergies, which cause sudden swelling of the airway (e.g., croup).

An infant or child whose airway is partially blocked because of swelling needs urgent medical attention. Don't waste time attempting to relieve this type of obstruction. An infant or child who has a progressive airway obstruction — a barking cough or noisy breathing — requires immediate transportation to the nearest medical facility.

An infant or child who is choking on a small object should be encouraged to persist with coughing and breathing efforts as long as their cough is effective. Relief of the obstruction should be attempted only if the cough is, or becomes, ineffective. If they have any difficulty breathing, the attendant must assist the breathing.

An infant or child who successfully clears their airway should be watched carefully. Referral to a physician is always mandatory.

All airway obstructions place the patient in the rapid transport category — arrange for immediate medical aid.

Complete airway obstruction — child

The procedures for managing an obstructed airway for a child is the same as for an adult, with the awareness that it will take less force for the abdominal thrusts, back blows, and chest compressions (see page 58, Airway Management: Procedures for Clearing the Airway).

Complete airway obstruction — infant

Conscious infant

If the infant is conscious, position the infant between your forearms and hands so that the infant is face down with the head lower than the trunk. Support the infant's head and neck and give up to five sharp back blows between the shoulder blades then turn the infant face up. Keep the head low and give up to five chest thrusts using two fingers, placed on the centre of the chest, just below the nipple line. Continue back blows and chest thrusts until the obstruction is cleared or the infant loses consciousness.

Infant with decreased level of consciousness

If the infant becomes unconscious, give 30 chest compressions as described previously under Infant Resuscitation. Look in the mouth and remove any foreign object seen. Try to ventilate. If air does not go in, repeat cycles of 30 compressions, mouth checks, and attempts to ventilate. If the object is removed or air goes in, give two breaths and continue CPR or, if the infant starts to breathe or cry, proceed with the primary survey.

Fatalities

In the case of a workplace fatality, the first aid attendant may be the only person present who can bring order to an emotionally charged scene.

Cases and signs of obvious death include decapitation, transection, decomposition, complete submersion for longer than 60 minutes, or resuscitation that has been ongoing for 30 minutes without even the temporary return of a spontaneous pulse in patients with normal temperatures. If there is any doubt whether the patient is dead, the attendant does not have the authority to pronounce death.

Where doubt exists, the patient must be treated and resuscitation attempted. Apply the appropriate treatments, as outlined in this manual, depending upon the patient's condition.

When there is a workplace fatality, the attendant may be called upon to assist the employer in ensuring that the required agencies are notified — including the police and WorkSafeBC. The attendant can also play a part in obtaining the names of witnesses and recording the history of the accident.

The worker's body must not be moved until the coroner gives permission to do so.

Where death has been certified by a medical doctor or coroner, the body must be properly cared for. Depending upon locale, the coroner's office or local ambulance service may be responsible for transportation of the body. If it is necessary for the body to remain at the workplace due to transportation difficulties, keep it in a cool, isolated place. Dress any wounds and cover body openings with large drainage dressings. Close the mouth and eyelids. Do not turn or incline the head to the side. Cover the body with a clean sheet or encase it in a body bag, if one is available.

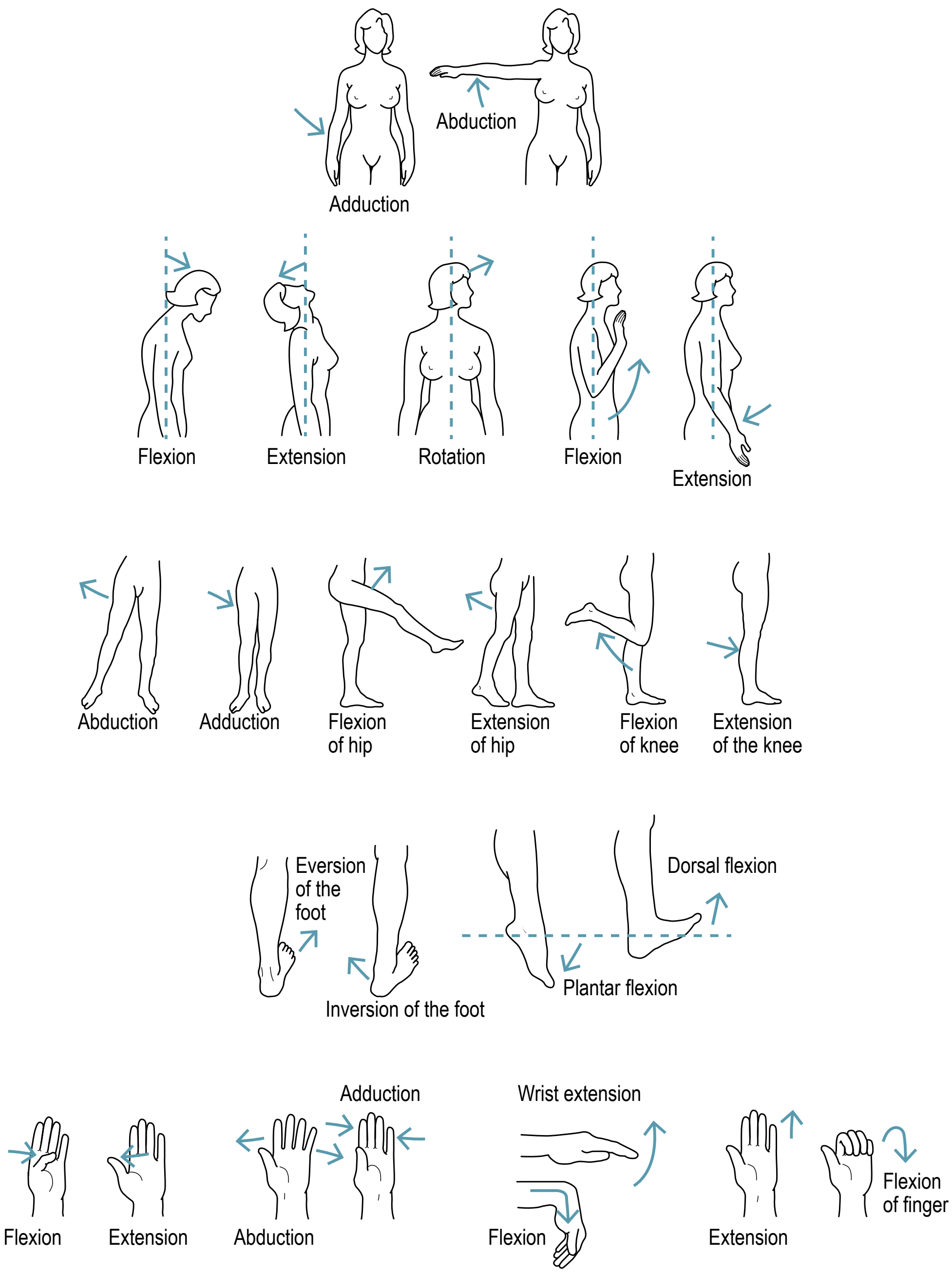
With witnesses present, collect and itemize, in quadruplicate, the worker's personal belongings and have a witness sign the itemized list. Keep the personal belongings for the police.

Where practicable, the scene of any workplace incident involving a fatality should be left untouched, except for activity necessitated by rescue work or to prevent further failure of equipment or injuries. The scene must not be disturbed until the incident has been investigated and permission to clear the scene has been granted by the appropriate authorities.

Appendix C

Medical terminology — body movement

Adduction — movement towards the midline of the body
Abduction — movement away from the midline of the body
Eversion — the process of turning outward
Extension — the act of straightening
Flexion — the act of bending
Inversion — the process of turning inward
Rotation — the process of turning around an axis (fixed point)



NEXUS low-risk criteria

According to the NEXUS low-risk criteria, cervical spine radiography is indicated for trauma patients unless they exhibit ALL of the following criteria:

- No posterior midline cervical spine tenderness
- No evidence of intoxication
- Normal level of alertness
- No focal neurological deficit
- No painful distracting injuries

Explanations

These are for purposes of clarity only. There are not precise definitions for the individual NEXUS Criteria, which are subject to interpretation by individual physicians.

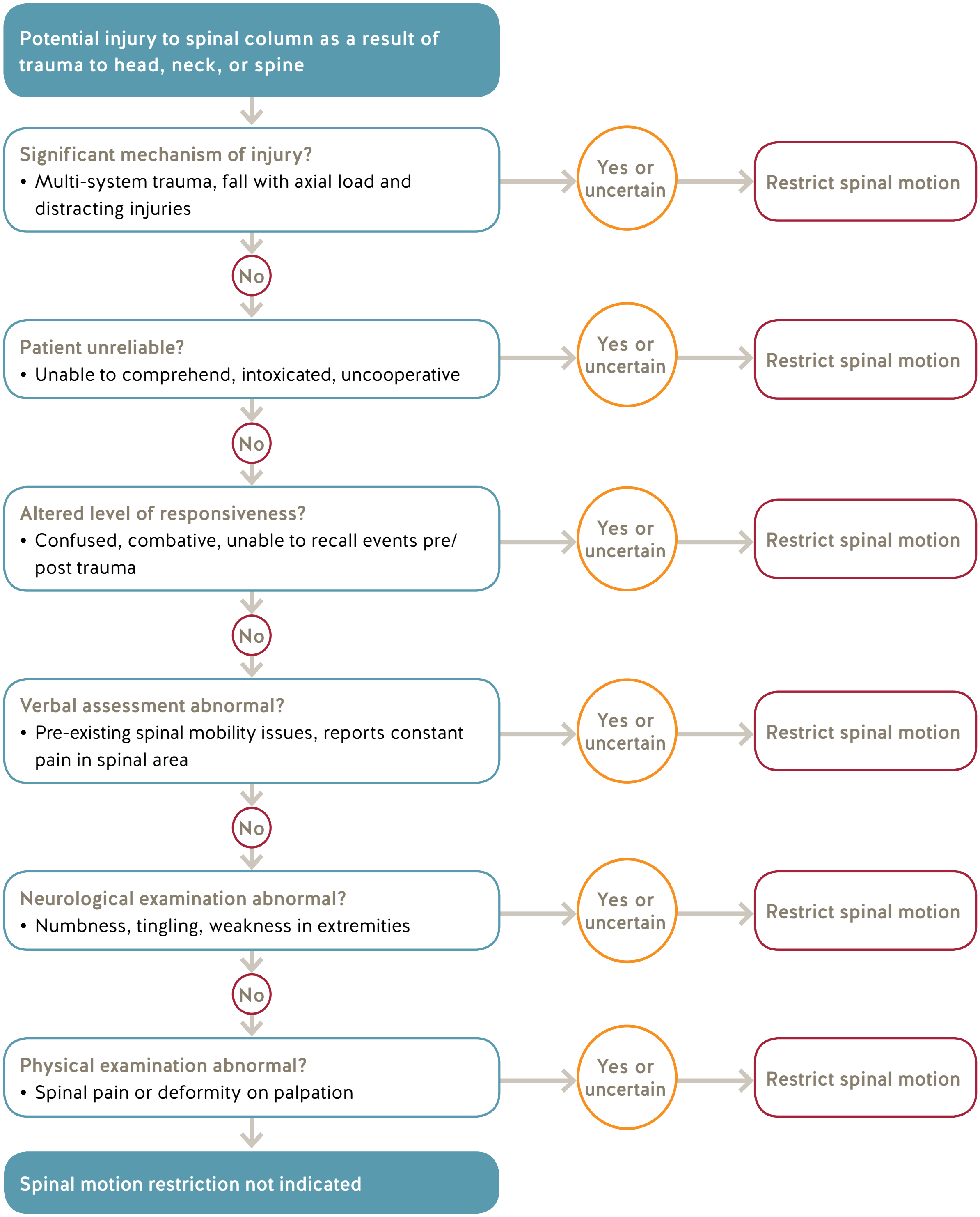
- Midline posterior bony cervical spine tenderness is present if the patient complains of pain on palpation of the posterior midline neck from the nuchal ridge to the prominence of the first thoracic vertebra, or if the patient evinces pain with direct palpation of any cervical spinous process.
- Patients should be considered intoxicated if they have either of the following:
  - A recent history by the patient or an observer of intoxication or intoxicating ingestion.
  - Evidence of intoxication on physical examination such as odor of alcohol, slurred speech, ataxia, dysmetria or other cerebellar findings, or any behavior consistent with intoxication. Patients may also be considered to be intoxicated if tests of bodily secretions are positive for drugs (including but not limited to alcohol) that affect level of alertness.

1. An altered level of alertness can include any of the following:
   - Glasgow Coma Scale score of 14 or less.
   - Disorientation to person, place, time, or events.
   - Inability to remember three objects at five minutes.
   - Delayed or inappropriate response to external stimuli.
2. Any focal neurologic complaint (by history) or finding (on motor or sensory examination).
3. No precise definition for distracting painful injury is possible. This includes any condition thought by the clinician to be producing pain sufficient to distract the patient from a second (neck) injury. Examples may include, but are not limited to:
   - Any long bone fracture.
   - A visceral injury requiring surgical consultation.
   - A large laceration, degloving injury, or crush injury.
   - Large burns.
   - Any other injury producing acute functional impairment

Physicians may also classify any injury as distracting if it is thought to have the potential to impair the patient's ability to appreciate other injuries.

Spinal motion restriction decision matrix

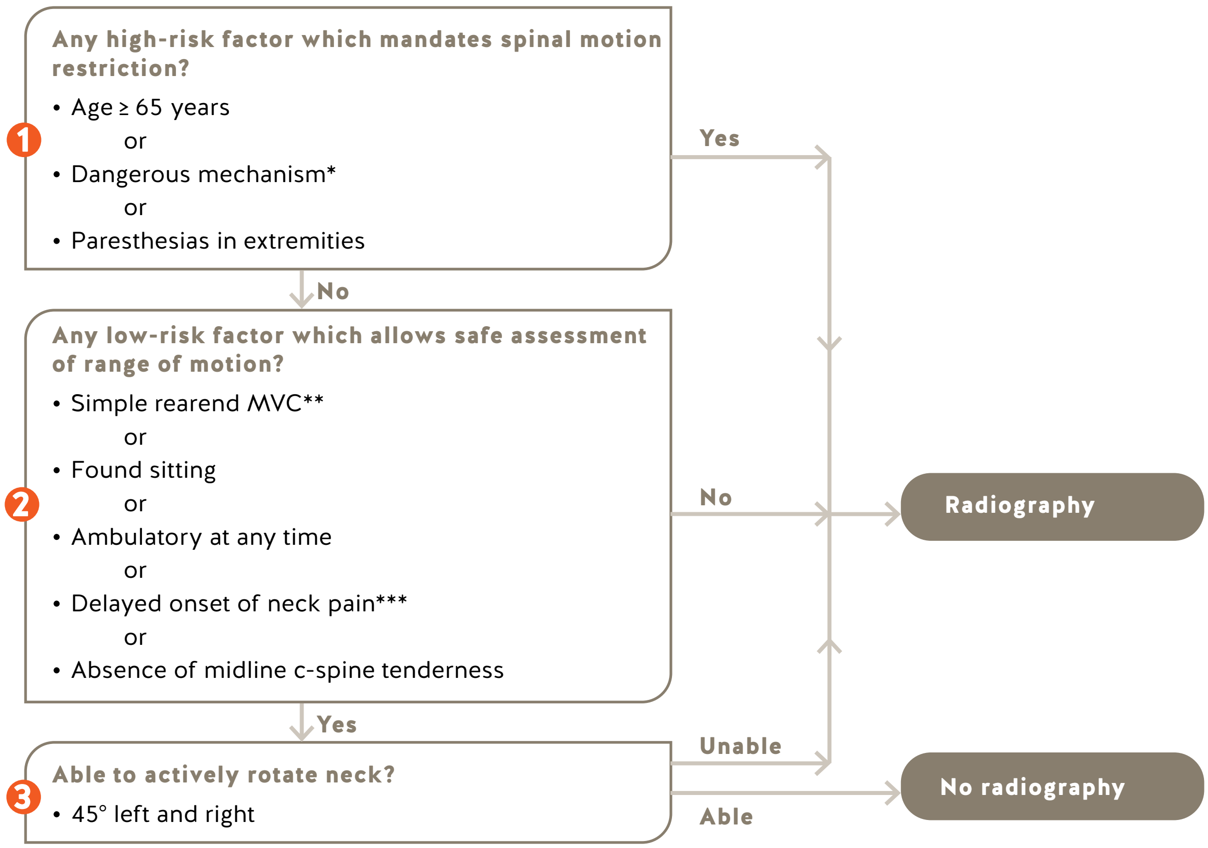
Spinal motion restriction decision matrix



Canadian C-spine rule

The Canadian C-Spine Rule

For alert (GCS=15) and stable trauma patients where cervical spine injury is a concern



* Dangerous mechanism:
- fall from elevation ≥ 3 feet/5 stairs
- axial load to head, e.g., diving
- MVC high speed (>100 km/hr), rollover, ejection
- motorized recreational vehicles
- bicycle collision

** Simple rearend MVC excludes:
- pushed into oncoming traffic
- hit by bus/large truck
- rollover
- hit by high speed vehicle

*** Delayed:
- i.e., not immediate onset of neck pain

Sources

Sources

Sources

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Appendix D: NEXUS Low-Risk Criteria
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Appendix E: Spinal Motion Restriction Decision Matrix
Spinal Motion Restriction Decision Matrix
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Appendix F: Canadian C-Spine Rule
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Illustrations

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Glossary

Glossary

Pronunciation

The pronunciation of words is indicated by a phonetic spelling that appears in parentheses immediately following most of the entries. For ease of interpretation, these re-spellings are presented with a minimum of diacritical markings (marks over vowels to indicate pronunciation).

Only two diacritics are used in this glossary: the macron (¯), showing the long sound of vowels, as the “a” in rate, and the breve (˘), showing the short sound of vowels, as the “e” in bell.

Accents

Accents are marks used to indicate stress on syllables. A single accent (') is called a primary accent. A double accent (") is called a secondary accent. A syllable with a secondary accent receives less stress than a syllable with a primary accent. Example: antiseptic (an"ti-sep'tik).

Medical prefixes and suffixes

epi-:	upon, over
hemo-:	blood
hyper-:	abnormally increased, excessive
hypo-:	abnormally decreased, deficient
inter-:	between
intra-:	inside of, within
myo-:	muscle
para-:	beside, beyond; accessory to; apart from; against
peri-:	near, around
pneumo-:	of the lung
retro-:	behind or backward
sub-:	under
super-:	above or excessive
supra-:	above, over
-itis:	inflammation

A

abdomen (ab'domen): The large cavity below the diaphragm and above the pelvis.

abduction (ab-dŭk'shun): Movement of a limb away from the central axis of the body.

abrasion (ah-brā'zhun): The loss of a partial thickness of skin from rubbing or scraping on a hard or rough surface.

abscess (ab'ses): A cavity containing pus, formed by disintegration of tissues.

acetabulum (asĕ-tab'u-lum): The large, cup-shaped depression on the external surface of the pelvic (innominate) bone, into which the head of the femur fits.

acetone (as'ĕ-tōn): A colourless, volatile liquid ketone used as a solvent of organic compounds.

Achilles (ah-kil'ēz) tendon: The fibrous cord attaching muscles of the leg to the heel.

acid (as'id): A substance that yields hydrogen ions in solution; a substance that has a pH less than 7.0.

acidosis (as ĭ-dō'sis): A state of increased acidity of body tissues and fluids.

acromion (ah-krō'me-on): A lateral bony process of the scapula.

acute (ah-kyoōt'): Having severe symptoms and a short course.

acute abdomen: A condition caused by an irritation or inflammation of the peritoneum.

Adam’s Apple: The prominence of the thyroid cartilage of the larynx.

adduction (ad-dŭk'shun): Movement of a limb towards the central axis of the body.

adrenaline (ah-drĕn'ah-lin): A hormone that acts as a stimulant.

aerobic (ĕ-rō'bik): Requiring air or free oxygen to live.

agonal respiration (agŏ-năl reśpĕr-āshŭn): Shallow breathing pattern with sporadic gasping breaths often related to cardiac arrest.

air hunger: Distressed or laboured breathing; dyspnea.

airway: The passage through which air enters and leaves the lungs; a mechanical device used for maintaining unobstructed respiration.

alignment: The placement of an injured limb in a straight line.

alkali (ăl'kah-lī): A substance with a pH greater than 7.0.

alkalosis (al kah-lo'sis): An alteration in body chemistry due to low carbon dioxide levels.

allergen (al'ler-jen): A substance capable of inducing allergy or hypersensitivity.

allergy (al'ler-jē): A mild to severe reaction to a substance to which an individual is sensitive.

alveoli (al-vē'ō-li): The air sacs of the lungs.

ambulatory (ăm'byoō-lah-torē): Able to walk without assistance.

amnesia (am-nē'zhē-ah): Loss of memory due to an illness or injury.

amniotic (am-neē-ŏt'ik) **fluid**: The liquid that surrounds the fetus in the uterus and protects it from injury.

amputation (am"pyoō-tā'shun): The removal of a limb or other part of the body.

anaerobic (ăn ĕ-rō'bik): Needing no air or free oxygen to live.

anatomical (an a-tŏm'ĭ-kal) **position**: The body standing erect, arms at the sides and palms forward.

anatomy (ah-năt'o-mē): The study of body structure.

anemia (ah-nē'mē-ah): A condition in which there is a below-normal number of circulating red cells in the blood.

anesthetic (an"es-thĕt'ik): A drug that causes loss of sensation in part or all of the body.

aneurysm (an'yoō-rĭzm): A localized abnormal dilation of a blood vessel due to a congenital effect or a weakness of the wall of the vessel.

angina (an-jī'nah) **pectoris** (pēk'tor-is): A distinctive type of pain that results from an inadequate supply of blood to the heart muscle.

angulation (an"gyoō-lā'shun): A fractured limb positioned at an angle distal to the fracture site.

anoxia (an-ŏk'sē-ah): An abnormal lack of oxygen.

anterior (an-tēr'ē-or): The front of the body surface.

antibiotic (an"tĭ-bī-ot'ik): A chemical substance produced by a microorganism that has the capacity to kill other microorganisms.

antidote (an'tĭ-dōt): An agent that counteracts a poison.

antiseptic (an"ti-sep'tik): A substance used to destroy bacteria.

anus (ā'nus): The opening of the rectum on the body surface.

aorta (ā-or'tah): The largest artery in the body; the main arterial trunk from which the systemic arterial system proceeds. It arises from the left ventricle of the heart.

apnea (ăp-nē'ah): The cessation of breathing.

appendix (ah-pen'diks): A long, narrow tube, connected in the lower right abdomen to the cecum. Inflammation of this tube is called appendicitis.

arachnoid (ah-rak'noid): The middle layer of the meninges, which protects the brain.

arrhythmia (ah-rĭth'mē-ah): Variation from the normal rhythm of the heartbeat.

arteriolar (ar-tĭr'ē-ōl"ar) **resistance**: The back pressure exerted by the arterioles on the blood flow.

arteriole (ar-tĭr'ē-ōl"): A tiny arterial branch.

artery (ar'ter-ē): A muscular, thick-walled blood vessel that carries blood away from the heart.

arthritis (ar-thrī'tis): Inflammation of a joint, usually accompanied by pain and frequently by changes in the joint structure.

articulation (ar-tik"u-lā'shun): A meeting place of two bones, forming a joint.

artificial ventilation: Any method used to force air in and out of the lungs of a person who is not breathing.

asphyxia (ăs-fik'sē-ah): Suffocation due to decreased oxygen and increased carbon dioxide in the blood.

aspiration (as"pĭ-rā'shun): The act of inhaling foreign material into the lungs.

asthma (az'mah): A disease of the lungs characterized by bronchial spasms.

asymmetry (ā-sim'ĕ-trē): Lack of correspondence of parts or organs on opposite sides of the body.

atherosclerosis (ath"er-ō-skle-rō'sis): A form of "hardening," or blockage, of the arteries.

atrium (ā'trē-ŭm): Either of two receiving chambers of the heart from which blood passes to the ventricles.

auditory (aw'dĭ-to"rē): Pertaining to the sense of hearing.

aura (aw'rah): A hallucination (caused by an epileptic seizure) that may involve the senses of smell, sight, hearing, and taste.

auricle (aw'rĭ-k'l): The part of the ear outside the head.

automated external defibrillator (de-fib'rĭ-la"ter)(**AED**): A portable electronic device that can detect an abnormal electrical rhythm in the heart and then automatically send an electric shock to the heart to try to restore a normal rhythm.

autonomic (aw"to-nŏm'ik): Not subject to voluntary control.

autonomic nervous system: The part of the nervous system concerned with the function of the cardiac muscle, glands, and smooth muscles.

avulsion (ah-vŭl'shun): The tearing away of a body part or tissue.

axilla (ak-sĭl'ah): Armpit.

axis (ak'sis): A line that runs through the centre of the body or about which a part revolves.

B

bacteria (bak-tĭr'ē-ah)(singular: **bacterium**): Microscopic organisms that can cause disease.

ball-and-socket: A type of joint with a wide range of movement, such as the shoulder and hip joints.

barometric pressure: A measurement of atmospheric pressure.

barotrauma (bar"ō-traw'mah): Injury due to increased environmental pressure.

Battle's sign: The signs of bruising and swelling found behind the ear as a result of basilar skull fracture.

bile: A greenish-yellow fluid secreted by the liver that aids in fat digestion.

bladder (blăd'er): A musculomembranous sac that collects and stores fluids.

bleb: A small blister or bubble in the skin.

blister: A collection of plasma or blood in or under the epidermis.

blood: The fluid circulating through the heart, arteries, capillaries and veins. It carries nutritive materials and oxygen to body cells and removes waste products and carbon dioxide.

blood pressure: The pressure of the blood on the walls of the arteries, usually given in millimetres of mercury.

blood volume: The total quantity of blood in the body, usually given in litres.

bone: The hard form of connective tissue that constitutes most of the skeleton.

brachial (brā'kē-al) **artery**: The main artery of the upper arm; a continuation of the axillary artery that branches into the radial and ulnar arteries at the elbow.

brain: The part of the central nervous system contained in the cranial vault.

brain stem: The stem-like portion of the brain connecting the cerebral hemispheres with the spinal cord.

breech: The presentation in which a baby emerges feet or buttocks first.

bronchi (brong'kī)(singular: **bronchus** [brong'kus]): The larger passages off the trachea, conveying air to and within the lungs.

bronchiole (brong'kē-ōl): A subdivision of the bronchi.

bruise: An injury due to hemorrhage into tissue from ruptured vessels. If it is superficial, discolouration of skin may result (see ecchymosis). Also called a contusion.

burn: Injury to tissue caused by contact with heat, flame, chemicals, electricity, or radiation.

bursa (bur'sah): Small sacs containing fluid, found in the fascia under the skin or muscles, and around tendons. Situated in places where friction would otherwise develop.

buttocks (bŭt'oks): The external fleshy prominences posterior to the hips, formed by muscles and underlying structures.

C

calcaneus (kal-kā'nē-us): The heel bone.

canthus (kăn'thus): The angular junction of the eyelids at either corner of the eyes, designated outer (lateral) and inner (medial).

capillary (kap'Ĭ-lĕr"ē): A minute vessel that joins arterioles and venules.

carbon dioxide: An odourless, colourless gas that is a normal by-product of body metabolism, found in exhaled air.

carbon monoxide: A colourless, odourless, poisonous gas. When inhaled, it combines more readily with hemoglobin than does oxygen, causing central nervous system depression and asphyxiation.

carcinogenic (kar-sin'o-jĕn-ik): Causing cancer.

cardiac (kar'dē-ak): Pertaining to the heart.

cardiac arrest: Cessation of heart function.

cardiopulmonary (kar"dē-o-pul'mo-nĕr"ē) **resuscitation (CPR)**: Artificial ventilation and external cardiac compression.

cardiovascular (kar"dē-o-vas'ku-lar): Pertaining to the heart and blood vessels.

carotid (kah-rŏt'id) **artery**: One of the main arteries of the neck, which supplies blood to the head.

carpal (kar'pal) **bones**: The eight small bones of the wrist.

carpal tunnel syndrome: A compression of the median nerve at the wrist, which can result in numbness, tingling, burning, pain, and weakness in the limb.

carpopedal (kar"pō-pĕd'al) **spasm**: During severe attacks of hyperventilation, spasms of the fingers and wrists that can cause the hands to become stiff and flexed like claws.

cartilage (kar'tĭ-lij)(adjective: **cartilaginous** [kar'ti-laj"i-nus]): The white, elastic substance that is attached to articular bone surfaces and forms part of the skeleton. Also called gristle.

  cricoid (krī'koid) **cartilage**: The lowest cartilage of the larynx.

thyroid (thī'roid) **cartilage**: The shield-shaped cartilage of the larynx.

cataract (kat'ah-rakt): An opaqueness or clouding of the lens of the eye that results in diminished vision.

caustic (kaws'tik): A substance that causes a burning or corrosive effect on organic tissue.

cavity: A hollow or space.

cecum (sē'kum): The first portion of the large intestine.

cell: A mass of protoplasm containing a nucleus.

cellulitis (sel"u-li'tis): An infection or inflammation of cellular or connective tissue.

centigrade (Celsius): The temperature scale in which the freezing point of water is 0° and the boiling point at sea level is 100°.

central nervous system (CNS): The brain and spinal cord.

cerebellum: (ser"ĕ-bel'um): The smaller, posterior portion of the brain, mainly concerned with coordination of movement.

cerebrospinal (ser"ĕ-bro-spī'nal) **fluid (CSF)**: The fluid that surrounds the brain and spinal cord and that flows inside the central canal of the spinal cord and the four ventricles of the brain.

cerebrovascular (ser"ĕ-bro-vas'kyoō-lar) **accident (CVA)**: The stoppage of blood circulation to a section of the brain. Commonly referred to as a stroke.

cerebrum (ser'ĕ-brum): The portion of the brain that governs thought, reasoning, memory, sensation, and voluntary movement.

cervical (ser'vĭ-kal) **spine**: The first seven vertebrae of the spinal column.

cervix (ser'viks): The lower, narrower part of the uterus, which enters the upper part of the vagina.

chest: See thorax.

chest compressions: An external effort to artificially circulate a patient's blood.

cholesterol (ko-les'ter-ol): A fat-like substance that, in excess, can become deposited on the inner lining of arteries, causing narrowing and eventually blockage of the arteries.

chronic (kron'ik): Persisting for a long time.

chronic obstructive pulmonary disease (COPD): An illness that causes obstructive problems in the lower airways, such as chronic bronchitis, emphysema, and, sometimes, asthma.

circulatory (ser'kyoō-lah-tor"ē): Pertaining to the heart and blood vessels.

circulatory system: The network consisting of the blood, heart, blood vessels, and lymph vessels, concerned with the movement of blood and lymph.

clammy: Moist and cold.

clavicle (klăv'ĭ-k'l): The bone that articulates with the sternum and scapula. Also called the collarbone.

clitoris (klĭt'o-ris): One of the structures of the female genitalia.

clot: A thrombus; a lump; a semi-solidified mass, as of blood or lymph.

coagulation (ko-ag"yoō-lā'shun): The process of changing from a liquid to a thickened or solid state; the formation of a clot.

coccygeal (kŏk-sij'ē-al): Pertaining to the coccyx.

coccyx (kŏk'siks): The lowest part of the spine, composed of four small, fused vertebrae. Also called the tailbone.

cochlea (kōk'le-ah): A winding cone-shaped tube that forms a portion of the inner ear. It contains the receptor for hearing.

cognitive (kog'ni-tiv): Pertaining to awareness. The mental process by which knowledge is acquired.

collateral (kŏ-lat'er-al): Secondary or accessory, not direct or immediate; a small side branch, as of a blood vessel or nerve.

colon (kō'lon): The part of the large intestine extending from the cecum to the rectum.

coma (kō'mah): Unconsciousness from which the patient cannot be aroused.

communicable (kŏ-mu'nĭ-kah-b'l) **disease**: A disease that can be transmitted from one person to another.

concussion (kon-kŭsh'un): A violent shaking or jarring, usually of the head, leading to transient or prolonged loss of normal brain function.

conduction (kon-duk'shun): The transfer of heat by direct contact.

condyle (kŏn'dīl): The rounded prominence at the articular end of a bone.

congenital (kon-jĕn'ĭ-tal): Existing at or before birth.

congestion (kon-jes'chun): The presence of an excessive amount of blood or other fluid in an organ.

congestive heart failure: Failure of adequate ventricular function, causing a backup of blood or fluid into the lung.

conjunctiva (kon"junk-tī'vah): The delicate membrane that lines the eyelids and covers exposed surfaces of the eyeball.

connective tissue: A variety of cells grouped together to give structural support to different parts of the body.
conscious (kon'shus): Aware, knowing, with alert mental faculties; awake.
consensual (kon-sens'yoō-al) **reaction to light**: A similar reaction by both pupils to a stimulus applied to only one.
constrict (kon-strikt'): To decrease in diameter; shrink.
contagious (kon-tā'jus): Communicable; transmitted from one person to another by direct or indirect contact.
contaminate (kon-tam'ĭ-nate): To soil with foreign matter.
contraction (kon-trak'shun): In muscles, shortening or tension.
contusion (kon-toō'zhun): An injury that causes a hemorrhage into or beneath the skin but does not break the skin. Also called a bruise.
convection (kon-vek'shun): The transfer of heat by exposure to air or water that is cooler than body temperature.
convulsion (kon-vul'shun): A violent, involuntary contraction or series of contractions of the voluntary muscles; a seizure.
cornea (kor'nē-ah): The transparent anterior part of the eye covering the iris and the pupil.
coronary (kor'ŏ-nĕr"rē) **arteries**: The large arteries that branch from the ascending aorta and supply the heart muscle with oxygenated blood.
coronary artery disease: A disease that causes a progressive narrowing and eventual obstruction of the coronary arteries.
cortex (kor'teks): The outer layer of an organ or other structure, as distinguished from its inner substance.
costal (kos'tal): Pertaining to a rib.
costal arch (margin): The fused costal cartilages of ribs 7 to 10; the arch forms the upper limit of the abdomen.
CPR: See cardiopulmonary resuscitation.
cramp: A painful involuntary contraction of muscle.
cranial (krā'nē-al) **cavity**: The bony container for the brain.
crepitus (krĕp'ĭ-tus): A grating sound, made, for example, by two fractured bone ends rubbing together, or the bubbly sensation of air palpated in tissues.
critical incident stress: An ongoing reaction to a traumatic incident or accident, which may result in a range of emotional, cognitive, behavioural, and physical symptoms.
crowning: During birth, the appearance of the baby's head at the vaginal opening.
cruciate (kroō'shē-āt): Cross-shaped.
crush syndrome: The signs and symptoms of renal failure after prolonged crushing of a part, especially of a large muscle mass.
cutaneous (ku-tā'nē-us): Pertaining to the skin.
cyanide (sī'ah-nīd): A highly poisonous substance used in the extraction of gold and silver and also in the manufacture of synthetic rubber and textiles.
cyanosis (sī-ah-nō'sis): A bluish discolouration of the skin and mucous membranes due to lack of oxygen.

D

debriefing session: A session in which a confidential, non-judgmental meeting is held to lessen the trauma and stressful effects of an incident.
decapitation (dē-kăp"ĭ-tā'shun): Severing of the head from the body.
decerebrate (dē-sĕr'ĕ-brāt) **posture**: A posture of extension and internal rotation of one or both arms and extension of one or both legs, caused by injury to the brain.
decomposition: The decay of tissue after death.
decompression illness: Problems caused by exposure to elevated atmospheric pressure and decompression.
decorticate (dē-kor'tĭ-kāt) **posture**: A posture of flexed upper limbs and extended lower limbs, caused by injury to the brain.
defecate (dĕf'ĕ-kāt): To expel waste matter through the rectum.
defibrillator See automated external defibrillator
deformity (dē-for'mĭ-tē): Distortion of any part of the body, or general disfigurement of the body.
defusing session: A meeting between workers who have been exposed to a traumatic incident or accident and specially trained personnel who come to the site to assist the workers in dealing with their reactions.
dehydration (dē"hī-drā'shun): Excessive loss of water from the body or tissue.
delirium (dĕ-lēr'ē-um): A mental disturbance of relatively short duration, usually reflecting a toxic state, marked by hallucinations, delusions, excitement, restlessness, and incoherence.
dementia (dē-mĕn'shē-ah): A deteriorated mental state.
dentine (dĕn'tēn): The main tissues of the tooth surrounding the pulp cavity.

depressant (dē-prĕs'ant): A substance that can depress a body function or nerve activity. Common depressants are alcohol, marijuana, tranquillizers, and narcotics.

dermis (der'mis): The inner layer of the skin containing the skin appendages, hair follicles, sweat glands, nerves, and blood vessels.

diabetes (dī"ah-bē'tēz): A disease of the pancreas characterized by deficient insulin secretion.

diagnosis (dī"ag-nō'sis): The identification, through a series of tests and measurements, of a disease condition or the severity of an injury.

diaphoresis (dī"ah-fo-rē'sis): Sweating.

diaphragm (dī'ah-frăm): The muscle that separates the thoracic cavity from the abdominal cavity.

diarrhea (dī-ah-rē'ah): Rapid movement of fecal matter through the intestine, resulting in poor absorption of water, nutritive elements, and electrolytes. Diarrhea produces abnormally watery stools.

diastole (dī-as'to-lē): The phase of the cardiac cycle in which the ventricles of the heart relax between contractions.

digestion (dī-jĕs'chun): The process of converting food into chemical substances that can be absorbed into the blood and used by the body.

digit (dĭj'it): A finger or toe.

dilate (dī'lāt): To make or become larger or wider; expand, widen, enlarge.

disc: A circular or rounded flat plate; the layer of cartilage between vertebrae.

disease: A specific illness or disorder having a characteristic set of signs and symptoms that are detrimental to the well-being of the individual.

dislocation: The displacement of the ends of two bones at a joint so that the joint surfaces are no longer in proper contact.

displacement: Movement to an abnormal location or position.

distal: Remote; farther from any point of reference; in the extremities, farthest from the point of junction with the trunk of the body.

distention: The state of being stretched out or enlarged.

diuretic (dī"u-rĕt'ik): A substance that causes the body to lose fluid through increased urine production.

dive reflex: A primitive human response to immersion in cold water, in which blood flow is shut off to most parts of the body, except for the heart, lungs, and brain.

dorsal (dor'sal): Pertaining to the top of the foot.

duct (dŭkt): A passage with well-defined walls; especially, a tubular structure for the passage of excretions or secretions.

dura mater (dyoō'rah mā'ter): The outermost and toughest of the three meninges (membranes) of the brain and spinal cord.

dysfunction: Abnormal, inadequate, or impaired function of an organ or a part.

dyspnea (dĭsp-nē'ah): Shortness of breath.

E

ear: The organ of hearing.

ecchymosis (ek"ĭ-mō'sis): A discolouration of the skin resulting from bleeding under the skin. Bluish at first, it changes later to a greenish-yellow because of chemical changes in the pooled blood.

ectopic (ek-tŏp'ik) **pregnancy**: Development of the fertilized ovum outside the uterus.

edema (ĕ-dē'mah): A condition in which fluid escapes to the tissues from the vascular or lymphatic spaces and causes local or generalized swelling.

effusion (ĕ-fyoō'zhun): Escape of fluid into a part of the body, such as the pleural cavity.

ejaculation (e-jak"yoō-lā'shun): The expulsion of semen from the urethra by rhythmic contractions.

embolism (ĕm'bō-lizm): A blood clot or other plug, such as an air bubble or fat globule, that obstructs local circulation.

emphysema (em"fĭ-sē'mah): A chronic disease of the lung, characterized by extreme dilation of pulmonary air sacs and poor exchange of oxygen and carbon dioxide in the lungs.

endotracheal (en"dō-trā'kē-al): Within the trachea.

epicondyle (ep"ĭ-kŏn'dīl): A prominence upon a bone above the condyle.

epidermis (ep"ĭ-der'mis): The outermost layer of the skin.

epigastric (ep"ĭ-gas'trik): The upper and middle region of the abdomen, located within the sternal angle.

epiglottis (ep"ĭ-glŏt'is): The lid-like, cartilaginous structure overhanging the superior entrance to the larynx and trachea that closes while a person is swallowing.

epilepsy (ep'ĭ-lĕp"sē): A chronic disorder characterized by intermittent attacks of brain dysfunction, usually associated with some alteration of consciousness. The attacks may be confined to impaired behaviour or may progress to a generalized convulsion.

erect: Standing upright.

esophagus (ĕ-sŏf'ah-gŭs): The tube extending from the pharynx to the stomach.

evaporation: The mechanism through which the body is cooled by sweating.

eversion: The act of turning outward.

excretion (eks-krē'shun): The process of eliminating the residue of food and the waste products of metabolism.

exhale (exhalation): The act of breathing out or expelling air from the lungs; expiration.

exsanguination (eks-sang"wĭ-nā'shun): Extensive loss of blood due to internal or external hemorrhage.

extension (ek-sten'shun): The opposite of flexion; the act of straightening.

extremity: An upper or lower limb.

extricate (eks-trĭ'kāt): Remove from a dangerous environment.

extrude (ek-strōōd'): To squeeze out, or push out of normal position.

F

fallopian tube: A tube on each side of the female abdominal cavity that conveys the ovum from the ovary and sperm from the uterus.

fascia (făsh'ē-ah): A membrane that connects the skin with the underlying tissues and supports and separates muscles.

feces (fē'sēz): Waste matter discharged from the bowel, consisting of the undigested residue of food, intestinal mucosal cells, intestinal mucus, bacteria, and waste material.

femoral artery: The principal artery of the leg.

femur (fē'mur): The longest and largest bone in the body, extending from the pelvis to the knee; the thigh bone.

fetus (fēt'us): Developing young in the uterus.

fever: An elevated body temperature.

fibula (fib'yoō-lah): The lateral and smaller of the two bones of the leg, extending from just below the knee and forming the lateral wall of the ankle joint.

fissure (fish'er): Any cleft or groove.

flaccid (flă'sid): Without muscle tone.

flail segment: In a flail chest injury, that segment of the chest wall that lies between the rib fractures, which may move paradoxically with respiration.

flank: The part of the body below the ribs and above the ilium.

flexion: The act of bending; the movement by which the two ends of any jointed part are drawn closer to one another (the opposite of extension).

flushed: Description of the reddened skin caused by dilation of blood vessels.

follicle (fŏl'lĭ-k'l): A deep, narrow pit containing the root of the hair. The duct of the sebaceous gland opens into it.

foramen (fo-rah'men) **magnum**: A large opening in the anterior inferior part of the occipital bone between the cranial cavity and and the vertebral canal.

fracture: Any break in a bone.

- **basilar fracture**: A fracture at the base of the skull.
- **Colles' fracture**: A transverse fracture of the radius just above the wrist.
- **comminuted fracture**: A fracture in which the bone has been splintered or crushed.
- **compound (open) fracture**: A fracture with an open wound over the fracture site.
- **compression fracture**: A fracture produced by compression.
- **depressed fracture**: A fracture where a segment of the skull is depressed into the brain.
- **greenstick fracture**: An incomplete fracture causing partial disruption, splintering, or bending of a bone; it occurs in immature bones.
- **linear fracture**: A single fracture line in the bone of the skull, caused by trauma.
- **simple (closed) fracture**: An uncomplicated fracture; one that does not cause disruption of the skin.
- **spiral fracture**: A fracture that coils around the bone.
- **transverse fracture**: A fracture extending from side to side, at right angles to the long axis of the bone.

frontal lobe: The anterior portion of the cerebrum; the site of emotional control.

frostbite: An injury in which tissues are damaged by exposure to freezing temperatures.

frostnip: A minor injury without soft tissue damage caused by exposure to freezing temperatures.

fungus (plural: **fungi** [fun'jī]**)**: A single-celled organism that can cause disease in humans.

fused joint: A joint that forms a solid, immobile bony structure.

G

gallbladder: A pear-shaped sac located on the undersurface of the liver; collects and stores bile.

gangrene (gang'grēn): Death of tissue due to a deficient or absent blood supply.

gastric: Pertaining to the stomach.

gastric juice: The digestive fluid secreted by the glands of the stomach; a thin, colourless liquid, containing mainly hydrochloric acid, pepsin, and mucus.

gastroenteritis (gas"trō-ĕn"ter-ī'tis): Inflammation of the stomach and intestine.

gelatinous (jĕl-ătĭ-nus): Like jelly or softened gelatin.

genitalia (jen"ĭ-tā'lē-ah): The reproductive organs.

germ: A pathogenic microorganism, such as a bacterium or a virus.

gland: A group of cells that manufacture a secretion that is discharged and used in some other part of the body.

Glasgow Coma Scale: A measurement used to assess a patient's level of consciousness by scoring the eye-opening, verbal, and motor responses.

glottis (glŏt'is): The vocal apparatus of the larynx, consisting of the vocal cords and the opening between them.

glucose (gloō'kōs): A simple sugar.

gluteus (gloō'tē-us) maximus (mak'sĬ-mus): A large muscle in the buttocks.

glycemia (glĪ-sē'mē-ah): The presence of glucose in the blood.

granulation tissue: Meaty-looking, rough-textured tissue produced by the body to slowly heal large wounds from the inside out, when the wound cannot be closed initially.

greater trochanter (trō-kan'ter): The greater of two bony processes below the neck of the femur; a broad, flat, lateral surface serving as a point of attachment for several muscles.

groin: The depression between the thigh and the trunk.

guarding: Muscle tightening when the abdominal area is palpated, due to irritation or inflammation of the peritoneum.

gut: The bowel or the intestines.

H

hallucination (hah-loō"sĭ-nā'shun): A false perception, having no relationship to reality and not accounted for by external stimuli.

hamstring: The muscle on the posterior thigh that flexes, extends, and adducts the leg.

heart: The muscular pump of the cardiovascular system that is responsible for maintaining circulation of the blood.

heart attack: See myocardial infarction.

heat cramps: Intense muscle cramps caused by salt loss from profuse sweating.

heat exhaustion: Prostration due to an excessive loss of water and salt through sweating.

heat stroke: A condition that results from prolonged exposure to heat, causing a disturbance of the temperature-regulating mechanism of the body. Also referred to as sunstroke.

Heimlich manoeuvre: The Heimlich manoeuvre is the application by a second person of quick abdominal thrusts to clear an obstructed airway.

hematoma (hē"mah-tō'mah): A localized collection of blood in the tissues as a result of an injury or a broken blood vessel.

hemiplegia (hĕm-i-plē'jē-ah): Paralysis of one side of the body.

hemisphere (hĕm'ĭ-sfēr): Half of a spherical or roughly spherical object or structure — for example, the brain.

hemoglobin (hē"mō-glō'bin): The oxygen-carrying pigment of the red blood cells.

hemorrhage (hĕm'ŏ-rij): Escape of blood.

hemothorax (hē"mō-tho'raks): Bleeding into the pleural space or chest cavity.

hepatitis (hĕp"ah-tī'tis): Inflammation of the liver.

herniated (her"nē-ā'ted) **disc**: The bulging of an intervertebral disc or its nucleus.

hinge joint: A joint that allows motion in only one plane, such as the elbow and knee.

histamine (his'tah-mēn): A substance released from body cells that is partially responsible for allergic reactions.

hives: Blotchy areas of raised reddish-pink tissue caused by an allergic reaction.

hormone (hōr'mōn): A substance secreted by an endocrine gland that acts on other glands and organs of the body.

humerus (hyoō'mer-us): The bone of the upper arm that extends from the shoulder to the elbow.

hydrocarbon (hi"drō-kar'bon): A petroleum product.

hypertension (hi"per-ten'shun): High blood pressure.

hyperthermia (hi"per-ther'mē-ah): Elevated body temperature.

hyphema (hi-fē'mah): Bleeding within the eyeball.

hypotension (hi"pō-ten'shun): Low blood pressure.

hypothermia (hi"pō-ther'mē-ah): Low body temperature.
hypotonic (hi"pō-tŏn'ik): A solution having less salt than normal body fluid.
hypoxemia (hi"pŏk-sē'mē-ah): Inadequate oxygen supply in the blood.
hypoxia (hi-pŏk'sē-ah): Diminished availability of oxygen to the body tissues.

I

ileus (ĭl'ē-us): Intestinal obstruction.
iliac (ĭl'ē-ăk) **crest**: The top edge of the ilium, palpable just below the lower ribs.
ilium (ĭl'ē-um): The lateral, flaring portion of the pelvic bone.
immobilize (im-mō'bil-īz): To render incapable of movement.
immune (ĭ-myoōn'): Protected from contracting a disease.
incontinent (in-kon'tĭ-nent): Inability to retain urine or feces through loss of muscle control due to injury or disease.
incus (ing'kus): One of the three tiny bones of the middle ear that connect the external ear to the nerve centre in the inner ear.
infarct (in'farkt): A local area of cell or tissue death.
infection (in-fek'shun): An invasion of the body by pathogenic microorganisms.
inferior (in-fēr'ē-or): Situated below.
inflammation (in"flah-mā'shun): A tissue response to injury or irritation of the cells, consisting of redness, swelling, and pain or tenderness.
inflammatory (in"flah-mah'to-rē) **exudate** (eks'oō-dāt): An accumulation of fluid at an injury site, containing white blood cells, cellular debris from dead tissue, and some live germs.
ingest: To take into the body by mouth.
inguinal (ing'gwĭ-nal): Pertaining to the groin.
inhale (inhalation): To draw air or other gases into the lungs; inspiration.
injection: The act of forcing a liquid through a needle or other tube through the skin into the body.
injury: A specific impairment of body structure or function caused by an outside agent or force. May be physical, chemical, or psychological.
innominate (ĭ-nom'ĭ-nāt) **bone**: The bone forming one-half of the pelvic girdle and arising from the fusion of the ilium, the ischium, and the pubis.
insulin (in'sŭ-lin): A hormone secreted into the blood by the pancreas that permits utilization of sugar by the body. Also used therapeutically in the treatment of diabetes.
intestine (small and large):
- **small**: The distal portion of the small bowel, extending from the stomach to the cecum.
- **large**: The portion of the digestive tube extending from the small intestine to the anus, comprising the cecum, colon, and rectum; the large bowel.

intubation (in"tū-bā'shun): Insertion of a tube into the larynx to ensure air exchange between the airway and the lungs.
inversion (in-ver'zhun): A turning inward.
ipecac (ip'ĕ-kak): A substance that can cause vomiting.
iris: The coloured portion of the eye, surrounding the pupil.
irritant: A substance that causes an inflammatory reaction when it comes in contact with body tissues.
ischemia (is-kē'mē-ah): Inadequate perfusion of fluids to an area of the body.
ischial (is'kē-al) **tuberosity** (tu$"bĕ-rŏs'i-tē): A protuberance on the ischium lateral to the anus that bears weight when a person is seated.
ischium (is'kē-um): The posterior, distal portion of the hip bone.

J

joint: A point at which two or more bones articulate.
joint capsule: A fibrous sac, containing a transparent, viscid fluid called synovial fluid, that encases a joint.
jugular veins: Large veins that return blood from the head, neck, and face to the superior vena cava.

K

ketoacidosis (kē"tō-ah"sĭ-dō'sis): A condition resulting from the accumulation of acid in the body, caused by badly controlled diabetes.
kidneys: Two organs that filter the blood and produce urine; they also regulate salt and water balance in the body.

L

laceration (lăs"ĕ-rā'shun): A wound resulting from tearing or cutting of tissue.
lacrimal (lăk'rĭ-mal): Pertaining to tears.

lacrimal gland: The gland located at the upper, outer corner of the eye that secretes tears.

lamina (lămĭ-nah): A flattened membrane on either side of the arch of a vertebra.

laryngospasm (lah"ring'gō-spazm): Reflex closure of the airway.

larynx (lar'inks): The organ of voice production.

lateral (lat'er-al): Pertaining to or situated at the side; away from the midline.

lens (lenz): The portion of the eye that focuses light rays onto the retina.

lethargy (leth'ar-jē): A condition of drowsiness or indifference.

lifting device: Anything used to lift a patient into or onto a stretcher.

ligament (lig'ah-ment): A band of fibrous tissue connecting bones or cartilages that serves to support and strengthen joints.

liver: The large organ in the right upper quadrant of the abdomen that stores and filters blood, secretes bile, converts sugars into glycogen, and performs many other metabolic activities.

lobe: A specific portion of an organ or gland.

lucidity (lū-sid'i-tē)(adjective: **lucid**): Awareness and clarity of the thinking process.

lumbar spine: The five individual vertebrae located between the thoracic vertebrae and the sacrum.

lungs: Two spongy organs of respiration contained in the thoracic cavity.

lymph (lĭmf): A colourless fluid formed in tissue spaces throughout the body. It is gathered into small vessels that return it to general circulation.

lymph node (gland): A rounded body of accumulations of lymph tissue found at intervals along the course of the lymphatic vessels.

lymphadenitis (lim-făd"ĕ-nī'tis): Inflammation of the lymph glands.

lymphangitis (lim"făn-jī'tis): Inflammation of the lymphatic vessels.

lymphocyte (lim'fō-sĪt): A type of white blood cell.

M

malaise (mal-āz'): General feeling of discomfort or uneasiness, often indicative of an infection.

malleolus (mah-lē'ō-lus): A rounded process, such as the one on each side of the ankle joint.

malleus (măl'ē-us): One of the three tiny bones of the middle ear that connect the external ear to the nerve centre in the inner ear.

malpresentation (mal"prez-en-tā'shun): Faulty presentation of the fetus at birth.

mandible (man'dĬ-b'l): The bone of the lower jaw.

manipulate (mah-nip'u-lāt): To alter the position of a joint injury to improve circulation to the limb.

maxilla (mak-sĬl'ah): The bone of the upper jaw.

meatus (mē-ā'tus): An opening or passage into the body.

meconium (mĕ-kō'nē-um): Feces passed into the amniotic fluid when a baby is deprived of oxygen during birth.

medial (mē'dē-al): In or towards the midline or centre of the body.

mediastinum (mē"dē-ah-stī'num): The tissues and organs between the sternum and the thoracic vertebral column.

membrane (mem'brān): A thin layer of pliable tissue that covers a surface, lines a cavity, or divides a space or organ.

meninges (mĕn-in'jēz): The three layers of membranes that cover the brain and spinal cord — the dura mater, arachnoid, and pia mater.

meniscus (mĕ-nis'kus): Crescent-shaped fibrocartilage in the knee joint.

metabolism (mĕ-tab'ō-lizm): All the physical and chemical changes that take place within an organism.

metacarpal (mĕt"ah-kar'pal) **bones**: The five bones of the hand between the wrist (carpal) and the fingers (phalanges).

metatarsal (mĕt"ah-tar'sal) **bones**: The five bones of the foot between the ankle (tarsal) and the toes (phalanges).

midline: An imaginary line drawn from the top of the head through the nose and down to the navel.

morbidity (mor-bid'ĭ-tē): The condition of being diseased. Also, the ratio of sick to well persons in a community or group of people.

mortality (mor-tal'ĭ-tē): The ratio of actual deaths to expected deaths.

mortice (mor'tis): A hole in a framework designed to receive the end of some other parts.

motor nerve: A nerve that causes a contraction in a skeletal muscle.

mucus (myoō'kus): A slimy semi-fluid secreted in mucous membranes.

muscle: A tissue which, by contraction, produces movement of an organ or other part of the body.

cardiac muscle: Specialized muscle that contracts rhythmically.

skeletal muscle: Muscle attached to and moving the bones, generally under voluntary control.

smooth muscle: Muscle comprising the walls of the internal organs, blood vessels, hair follicles, and other appendages; generally it is not under voluntary control.

myocardial (mī-ō-kar'dē-al) **infarction**: Damage or death of an area of the heart muscle (myocardium), resulting from a reduction in the blood supply.

N

naloxone [nal-oks´ōn]: A narcotic antagonist used to reverse the effects of previously administered narcotics.

narcosis (nar-kō'sis): A stuporous state.

nasal (nā'zal): Pertaining to the nose.

nasopharynx (nā"zō-fĕr'inks): The uppermost region of the throat, from behind the nose to the soft palate.

nausea (naw'zē-ah): A feeling that vomiting may be imminent.

navel (nā'vel): The scar marking the site of the attachment of the umbilical cord of the fetus.

necrosis (nĕ-krō'sis): Death of cells or localized tissue.

nerve: A collection of fibres in a cord-like structure, which convey impulses between the central nervous system and some other region of the body.

neurological (nyoō-rō-lŏj'ik-al): Pertaining to the nervous system.

nitroglycerin (nī"trō-glĭs'er-in): A vasodilator used in the treatment of angina.

noradrenalin (nor"ah-drĕn'ah-lin): A hormone that causes generalized vasoconstriction of arteries.

O

occipital (ok-sĭp'ĭ-t'l) **lobe**: The most posterior portion of the cerebrum.

occiput (ok'sĭ-put): The back of the head.

occlusion (ŏ-kloō'zhun): The act of closure or the state of being closed: an obstruction or a closing-off.

olecranon (ō-lek'rah-non) **process**: The bony projection of the ulna at the elbow.

optic (op'tik): Pertaining to the eye.

orbit: The bony cavity containing the eyeball and its associated muscles, vessels, and nerves.

organ: A collection of tissues that perform a special function.

ovary (ō'var-ē): A gland that produces female sex hormones and ova.

ovum (ō'vum)(plural: **ova**): Female sex cell.

oxygen: A colourless, odourless gas that supports combustion and is essential for life.

oximetry (ok-sim-i-tree): Determination of the oxygensaturation of arterial blood using an oximeter.

P

pallor: Paleness of the skin.

palpate (pal'pāt): To examine by feeling and pressing with the fingers and the palms of the hand.

palpitations (pal"pĭ-tā'shuns): Awareness of a rapid, throbbing heartbeat.

pancreas (pan'krē-as): A large, elongated gland situated transversely behind the stomach, between the spleen and the duodenum. It provides a major source of digestive enzymes and is the sole producer of the hormone insulin, which regulates the metabolism of sugar.

paradoxical (par"ah-dok'si-k'l) **movement**: The motion of the injured segment of a flail chest; opposite to the normal motion of the chest wall.

paralysis (pah-răl'ĭ-sis): The loss or impairment of motor function in a part due to a lesion of the neural or muscular mechanism.

paraplegia (păr"ah-plēj'ah): Paralysis of the lower part of the body.

parasite (păr'ah-sīt): A plant or animal that lives on or within another living organism, at whose expense it obtains some advantage.

parietal (pah-rī'ĕ-tal): Pertaining to the walls of a cavity.

patella (pah-tel'ah): The bone at the front of the knee; the kneecap.

patent (pā'tent): Open, unobstructed, or not closed.

pathogen (path'o-jen): Any disease-producing agent or microorganism.

pelvis: The bony ring connecting the trunk of the body to the lower extremities.

penis: The external genital organ of the male.

percutaneous (per"kyoō-tā'nē-us): Through the skin.

perforate (per'for-āt): To pierce or puncture.

perfusion (pur-fyoō'zhun): The flow of blood that carries oxygen and nutrients to the cells and takes carbon dioxide, acids, and other wastes away.

pericardial sac: The membrane enclosing the heart.

pericardial tamponade (tam"po-nād'): An accumulation of fluid in the pericardial sac, causing compression of the heart muscle.

perineum (per"ĭ-nē'um): The area between the vaginal opening and the anus in females or between the scrotum and the anus in males.

periosteum (per"ĭ-ŏs'tē-um): A layer of connective tissue that covers all bones.

peripheral (pĕr-if'er-al): Pertaining to the outside or surrounding area.

peripheral nervous system: The portion of the nervous system consisting of the nerves and ganglia outside the brain and spinal cord.

peristalsis (per"ĭ-stahl'sis): A progressive wave-like movement that occurs involuntarily in hollow tubes of the body, most evident in the digestive tract. The simultaneous contraction and relaxation progresses slowly for a short distance like a wave that forces the contents of the tube along.

peritoneum (per"ĭ-tō-nē'um): The membrane lying over the abdominal and pelvic organs; it also lines the abdominal cavity.

phalanx (fā'lanks)(plural: **phalanges** [fa-lan'jēz]): A bone of a finger or toe.

pharynx (far'inks): The cavity posterior to the nose and mouth and connecting with the esophagus and glottis; the throat.

physiology (fiz"ē-ŏl'ō-jē): The science that deals with the study of the functions of living organisms and their parts.

pia mater (pē'ah mā'ter): The delicate, innermost meningeal membrane enveloping the brain and spinal cord.

pinna (pin'ah): The part of the ear outside the head. Also called the auricle.

placenta (plah-sen'tah): A fetal organ that connects the fetus to the mother, through which the fetus absorbs oxygen, nutrients, and other substances and excretes carbon dioxide and other wastes.

placenta previa (prē'vē-ah): A placenta located in the lower uterine segment. It partially or entirely covers the cervical opening, instead of lying in the proper position higher on the uterine wall.

plaque (plăk): Fatty deposits within arteries.

plasma (plaz'mah): The liquid portion of whole blood.

platelet (plāt'let): Part of the cellular portion of the blood: essential for blood coagulation.

pleura (ploor'ah): The membrane covering the lungs and lining the walls of the thoracic cavity.

pleural (ploor'al) **space**: The potential space between the two layers of the pleura.

pneumonia (nyoō-mō'nē-ah): Inflammation of the lungs.

pneumothorax (nyoō-mō-tho'raks): The accumulation of air or gas in the pleural cavity. The air or gas usually enters as a result of a penetrating injury to the chest wall or a laceration of the lung.

point tenderness: An area of tenderness limited to two or three centimetres in diameter. It can be identified by pain caused by gentle pressure. Point tenderness can be located in any area of the body.

poison: A substance that harms the human body, damaging health or destroying life.

popliteal (pop"lĭ-tē'al) **artery**: The continuation of the femoral artery in the area behind the knee.

pore: A small opening or empty space.

posterior (pos-tēr'ē-or): Directed towards or situated at the back; opposite of anterior.

postictal (pōst-ik'tal): A state immediately following a seizure.

pre-eclampsia (prē"ĕ-klamp'sē-ah): A toxemia of late pregnancy characterized by hypertension and the presence of protein in the urine and edema, but without convulsions.

pressure sore: A sore or open wound caused by a lack of circulation to an area of the skin due to continued pressure on the area.

priapism (prī'ah-pizm): A persistent abnormal erection of the penis.

process: A prominence or projection, as from a bone.

prolapse of cord: Protrusion of the umbilical cord ahead of the presenting part of the fetus during labour.

prone: Lying face downward.

prostate (prŏs'tāt): A gland surrounding the urethra in males that adds a secretion to the semen.

protuberance (prō-tū'ber-ans): A projecting part.

proximal (prŏk'sĭ-mal): Nearer to the body trunk, when used to refer to a point on the limbs.

pulmonary (pul'mō-ner"ē): Pertaining to the lungs.

pulmonary artery: The large artery originating at the right ventricle of the heart, which carries blood to the lungs.

pulmonary embolism: An obstruction of the pulmonary artery or one of its branches by a clot or other plug.

pulmonary veins: The large veins that originate in the lungs, carrying blood back to the heart.

pulse: The wave of increased pressure felt along the arteries as a result of ventricular contraction.

- **brachial pulse**: The pulse felt in the mid-third of the upper arm just inferior to the bicep.
- **carotid pulse**: The pulse felt in the neck, lateral to the trachea and medial to the sternomastoid muscle.
- **dorsalis pedis**: The pulse felt on the top of the foot.
- **femoral pulse**: The pulse felt in the crease of the groin lateral to the symphysis pubis and inferior to the inguinal ligament.
- **posterior tibialis pulse**: The pulse felt on the inside of the foot behind the ankle.
- **radial pulse**: The pulse felt on the anterior wrist, just proximal to the base of the thumb.

puncture: A type of wound caused by a penetration of the body.

pupil: The opening at the centre of the iris of the eye.

pus: Tissue fluid containing the products of inflammation — white cells, bacteria, and broken-down tissue.

Q

quadrant (kwŏd'rant): One of four parts or quarters of the abdominal area.

quadriplegia (kwŏd"rĭ-plē'jē-ah): Paralysis of all four limbs.

R

radial artery: One of the major arteries of the forearm.

radiation: The transfer of heat without direct contact.

radius: The bone on the thumb side of the forearm.

rash: A temporary eruption on the skin.

rectum: The distal portion of the large intestine.

recumbent: Leaning back; reclining.

reduce (reduction): Restore a part to its normal place or relationship to other parts.

rehydrate: Restore water or fluid content to the body.

renal (rē'nal): Pertaining to the kidneys.

reproductive: Pertaining to the capacity of organisms to produce other organisms of the same kind.

respiration: The act of inhaling and exhaling.

retina (rĕt'ĭ-nah): The lining of the back of the eye that receives visual images.

retrosternal (rĕ"trō-ster'nal): Behind the sternum.

ribs: The long, flat, curved bones forming the wall of the thorax.

rigidity (rĭ-jid'ĭ-tē): Stiffness, inflexibility, immobility.

rotation (ro-ta'shun): Turning or rotating a body around its axis.

rupture (rup'chur): Tearing or disruption of tissue.

S

sacral (sā'kral) **spine**: The five fused vertebrae that constitute the sacrum, a part of the pelvic girdle.

sacrum (sā'krum): Five fused vertebrae forming a triangular-shaped bone. It lies just below the lumbar vertebrae.

saline (sā'lēn) **solution**: A solution of distilled water and salt.

saliva (sah-lī'vah): The clear, alkaline secretion from the glands of the mouth.

scab: Coagulation of blood, pus, or serum or a combination of these, forming a crust on the surface of an ulcer or wound.

scabies (skā'bēz): A microscopic mite that burrows under the skin.

scaphoid (skaf'oid): One of the carpal bones.

scapula (skap'yoō-lah): The shoulder blade.

sciatic (sī-at'ik) **nerve**: A nerve extending from the base of the spine down the posterior aspect of the thigh, with branches throughout the lower leg and foot.

sclera (sklĕ'rah): The white, tough, outer coat of the eyeball.

sebaceous (sĕ-bā'shus) **gland**: A gland in the dermis that secretes sebum.

sebum (sē'bum): An oily secretion of the sebaceous gland that lubricates the skin.

secretion: Any substance that is discharged onto an external or internal body surface.

seizure (sē'zhur): A sudden abnormal electrical discharge by brain cells.

- **focal motor seizure**: A seizure involving the part of the brain that controls motor activity. Typically, only one part of the body twitches or shakes.
- **grand mal (tonic-clonic) seizure**: A generalized seizure involving contraction of all muscles followed by rapid jerking activity of the extremities.
- **petit mal (absence) seizure**: A brief seizure (less than 1 minute), characterized by the patient staring into space and not responding to questions.

semilunar (sem"i-lū'nar) **cartilage**: One of the two intra-articular cartilages of the knee joint.

seminal vesicles (sem'in-al vĕs'ĭ-k'ls): Two storage pouches posterior to the male urinary bladder that receive and store spermatozoa.

seminiferous tubules (sem"ĭ-nĭf'er-us): Small tubes that collect the sperm from the testicles.

sensory nerve: A peripheral nerve that conducts impulses from a sense organ to the central nervous system.

sepsis (sep'sis): The presence of disease-producing microorganisms or their toxins in blood or other tissues.

septic shock: Shock from severe bacterial infection.

septicemia (sep"tĭ-sē'mē-ah): Generalized blood poisoning.

septum (sep'tum): A partition; a dividing wall between two spaces or cavities.

shock: The state of inadequate perfusion of the cells.

skeleton: The bones of the body.

skin: The outer covering of the body.

skull: The bones of the head.

spasm: Involuntary contraction of a muscle or a group of muscles.

spermatozoa (sper"ma-tō-zō'ah) (**sperm**): The male sex cell.

spinal canal: A bony channel formed by the vertebral bodies and neural arches. It contains and protects the spinal cord.

spinal column: All the vertebrae; the spine; the backbone.

spinal cord: The part of the central nervous system that extends from the foramen magnum to the upper end of the lumbar region.

spine: The vertebral column.

spinous (spī'nus): Pertaining to or like a spine.

spinal motion restriction: To maintain the spine in anatomic alignment minimizing gross movement.

spleen: An abdominal organ in the upper left quadrant of the abdominal cavity.

spontaneous: Occurring without external cause.

sprain: Twisting or stretching of ligaments at the joint.

sputum (spyoō'tum): Matter ejected from the trachea, bronchi, and lungs through the mouth.

stapes (stā'pēz): A small bone in the middle ear.

status epilepticus (stă'tus ep"ĭ-lep'tik-us): A condition in which a person has a prolonged seizure with convulsive activity lasting longer than 20 minutes, or has 2 or more successive seizures without regaining full consciousness in between.

sterile (ster'il): Not fertile; free from living microorganisms.

sternomastoid (stŭr"nō-mas'toid): Pertaining to the sternum and mastoid process.

sternum (stŭr'num)(breastbone): The long, flat bone located in the midline of the anterior part of the thoracic cage.

stimulant: An agent that produces an increase of activity in the body or a part of it.

stomach: The hollow digestive organ that receives food material from the esophagus.

strain: An overstretching of a muscle.

stretcher: A device for carrying patients.

stridor (strī'dor): A harsh, high-pitched respiratory sound.

stroke: A cerebrovascular accident.

subcutaneous emphysema: A condition in which air escapes into the subcutaneous tissue, especially the chest wall, neck, and face, causing a crackling sensation on palpation of the skin.

subungual (sub-ŭng'gwal): Beneath a nail.

suffocate: To asphyxiate; to be unable to breathe.

superficial (sū"per-fish'al): Situated on or near the surface.

superior: Location of an organ or body part above another organ or part.

supine: Lying flat, with the face upward.

symphysis pubis (sim'fĭ-sis pyoō'bis): The site of fusion of the pubic bones at the anterior midline.

syncope (sin'kĕ-pē): Temporary loss of consciousness due to inadequate blood supply to the brain.

syndrome (sin'drōm): A group of signs and symptoms that characterizes a condition or disease.

synovial (sĭn-o'vē-al) fluid: Clear fluid secreted by the synovial membrane and found in joint cavities, bursae, and tendon sheaths.

synovial membrane: The inner lining of the articular capsule in a synovial joint, permitting more or less free motion.

system: A set or series of interconnected or independent parts that act together in a common purpose or produce results impossible by the action of one alone.

- **circulatory system**: The transportation system of the body, delivering oxygen and other essential elements to the cells and carrying away waste products.
- **digestive system**: The system that processes the food we ingest.
- **genital system**: The system responsible for reproduction, including some organs shared with the urinary system.

nervous system: The control centre and network that co-ordinates all the systems of the body.

musculoskeletal system: The system that provides the framework of the body and allows movement.

respiratory system: The system responsible for the intake of oxygen and the elimination of carbon dioxide.

urinary system: The system that filters the blood and excretes most of the body's waste products.

systemic (sis-tem'ik): Pertaining to or affecting the body as a whole.

systole (sis'tō-lē)(**systolic pressure**): The contraction phase of the cardiac cycle.

systolic (sis-tŏl'ik) **blood pressure**: The higher blood pressure exerted by the blood on the arterial walls during ventricular contractions.

T

tachycardia (tăk"ē-kar'dē-ah): Rapid heartbeat.

tachypnea (tak"ip-nē'ah): Very rapid respiration.

talus: One of the tarsal bones.

tarsal bones: The seven bones that articulate between the lower leg and foot.

temporal (tem'por-al): Pertaining to the temple.

tendon: A fibrous cord that attaches a muscle to a bone.

tendon sheath: A tubular case or envelope surrounding a tendon.

tenosynovitis (ten"ō-sīn"ō-vī'tis): Inflammation of a tendon sheath.

infectious: Caused by microorganisms.

mechanical: Caused by repetitive overuse.

tension pneumothorax: A condition that develops when air is continually forced into the chest cavity outside the lung and is unable to escape; causing compression of the lung and heart.

testicles (tes'tĭ-k'ls): Egg-shaped glands that produce male sex hormones and spermatozoa. Also called testes.

testosterone (tes-tŏs'tĕ-rōn): A male sex hormone.

tetanus (tet'ah-nus): An infectious disease of the central nervous system caused by a bacterium found in soil, dust, and the bowels of cows and horses.

thorax (tho'raks): The upper part of the trunk between the neck and the abdomen; the chest.

thrombus (throm'bus): A blood clot that obstructs a blood vessel or a cavity of the heart.

tibia (tĭb'ē-ah): The shin bone.

tissue: A group or collection of similar cells that act together to perform a particular function.

tissue injury fluid: Plasma that accumulates in tissue spaces as a result of injury or irritation.

topical: Pertaining to a particular surface area.

torso (tor'sō): The body, exclusive of the head and limbs.

tourniquet (toōr'nĭ-ket): A bandage drawn tightly around a limb to stop hemorrhage from an injury.

toxemia (tok-sē'mē-ah): An abnormal condition associated with the presence of toxic substances in the blood.

toxic (tok'sik): Poisonous; pertaining to poison.

trachea (trā'kē-ah): The windpipe; the cartilaginous and membranous tube descending from the larynx and branching into the left and right main bronchi.

traction: The act of drawing or pulling.

transection (tran-sek'shun): Division by cutting.

transfusion (trans-fyoō'zhun): The introduction of whole blood or blood cellular components directly into the bloodstream.

trapezius (trah-pē'zē-us): The muscle of the top of the shoulder.

trauma (traw'mah): An injury inflicted, usually suddenly, by some physical or psychological factor.

traumatic asphyxia (traw-mat'ik as-fik'sē-ah): A condition caused by crushing trauma to the chest that forces blood back into the veins of the upper chest, neck, and head.

triage (trē-ahzh'): The sorting or selection of patients to determine the priority of care to be rendered to each.

tricep (trī'sep): The muscle of the posterior upper arm.

trunk: The body, exclusive of the head and limbs.

tympanic (tim-pan'ik) **membrane**: The eardrum.

U

ulcer (ul'ser): An open sore or lesion on the surface of the skin or a mucous membrane, sometimes accompanied by formation of pus.

ulna (ŭl'nah): The inner and larger bone of the forearm, on the side opposite the thumb.

ultraviolet radiation injury: Inflammation of the conjunctiva and/or the cornea, caused by excessive exposure to ultraviolet light, such as with welding.

umbilical (um-bilĭ-kal) **cord**: The structure that connects the umbilicus of the fetus to the placenta.

umbilicus (um-bil'ĭ-kus): The navel.

unconscious (un-kon'shus): Insensible; incapable of responding to sensory stimuli or of having subjective experiences.

uremia (yoō-rē'mē-ah): A toxic condition caused by retention of excessive by-products of protein metabolism in the blood.

ureter (yoō-rē'ter): The fibromuscular tube that conveys urine from the kidney to the bladder.

urethra (yoō-rē'thrah): The membranous canal that conveys urine from the bladder to outside the body.

urinary (yoō'rĭ-năr-ē) **bladder**: The organ that serves as a storage place for urine until it is discharged from the body.

urine: A fluid waste product excreted by the kidneys, stored in the bladder, and discharged through the urethra.

urticaria (er"tĭ-kă'rē-ah): Slightly elevated patches that are redder or paler than the surrounding skin and are often itchy. Also called hives.

uterus (yoō'ter-us): The hollow muscular organ in the female that protects the fetus.

V

vagina (vah-jī'nah): The muscular tube connecting the uterus with the external female genitalia.

vascular (vas'kyoō-lar): Pertaining to blood vessels.

vas deferens (văs dĕf'er-ens): The tube that carries spermatozoa from the testicles to the seminal vesicles.

vasoconstrictor (vās"ō-kŏn-strik'tor): A substance that causes a narrowing of the diameter of the blood vessels.

vasodilator (vās"ō-dī-lā'tor): A substance that causes a widening of the diameter of the blood vessels.

vault: A cavity or chamber.

vein (vān): A blood vessel that carries blood towards the heart.

vena cava (vē'na cā'va)(superior, inferior): The largest veins of the body, which return blood to the right atrium of the heart.

venom (vĕn'om): A toxic fluid substance secreted by a serpent, insect, or other animal.

ventilate: To move air in and out of the lungs.

ventricle (ven'trĭk'l): A thick-walled, muscular chamber of the heart that receives blood from the atrium and pumps it into the pulmonary or systemic circulation.

ventricular fibrillation (ven-trĭk'yoo-lar fi"brĭ-lā'shun): Rapid, ineffective contractions of the ventricular muscle.

venules (vĕn'yoōls): Any of the small vessels that collect blood from the capillaries and join to form veins.

vertebrae (ver'tĕ-bra): The bones of the spinal column.

vertebral (ver'tĕ-bral) **body**: The round, solid bone forming the front of each vertebra.

vertebral spine: The spinous process; the posterior projection of each vertebra.

vessels: Tubes or canals for conveying blood or lymph.

vestibular (ves-tĭb'yoō-lar) **apparatus**: The structure of the inner ear responsible for balance.

virus (vī'rus): A microscopic infectious agent.

vital signs: Measurement of body functions, including pulse, blood pressure, respiratory rate, temperature, and level of consciousness.

vitreous (vĭt'rē-us) **humor**: The transparent, gelatin-like substance that fills the inside of the eye.

void: To excrete urine from the bladder.

vomitus (vŏm'ĭ-tus): Material ejected from the stomach by vomiting.

vulva (vŭl'va): The external genital organs of the female.

W

wrist drop: Inability to extend the wrist or fingers, caused by a radial nerve injury.

X

xiphoid (zĭf'oid) **process**: The cartilage at the lower end of the sternum.

Z

zygoma (zī-gō'mah): The cheekbone.

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