CHAPTER 8

Determining Appropriate Emergency Injury Management

Objectives

When you finish this chapter you will be able to:

- Determine the components of an emergency action plan (EAP).
- Explain the importance of knowing cardiopulmonary resuscitation (CPR).
- Describe techniques for control of hemorrhage.
- Assess the types of shock and their management.
- Describe the various phases of injury assessment.
- Explain the importance of controlling swelling during initial acute injury management.
- Describe techniques for moving and transporting the injured athlete.
- Explain how to recognize and treat concussions.
- Become familiar with the signs and symptoms and the emergency treatment of stroke, sudden cardiac death, burns and poisoning.

Key Terms

- emergency action plan (EAP)
- primary survey
- secondary survey
- cardiopulmonary resuscitation (CPR)
- automated external defibrillator (AED)
- hemorrhage
- shock
- vital signs
- HOPS (history observation palpation special tests)
- POLICE
- concussion
- loss of consciousness (LOC)
- amnesia
- catastrophic injury
- sudden cardiac death syndrome (SCD)
- myocardial infarction (MI)
- stroke
- thrombus
- embolism
- aneurism
- transient ischemic attack (TIA)
- poisoning
- burns

An emergency is defined as "an unforeseen combination of circumstances and the resulting state that calls for immediate action." Certainly, most sports injuries do not result in life-or-death emergency situations, but when such situations do arise, prompt care is essential.[20] Time becomes the critical factor, and assistance to the injured athlete must be based on knowledge of what to do and how to do it—how to perform effective first aid immediately.[11] There is no room for uncertainty, indecision, or error. A mistake in the initial management of injury can prolong the time required for rehabilitation and can potentially create a life-threatening situation for the athlete.[11] Therefore it is critical to be well prepared to handle whatever emergency situation may arise.[25] first steps not only will be lifesaving but also may determine the degree and extent of permanent disability.

As discussed in Chapter 1, the sports medicine team—the coach, the athletic trainer, and the team physician—must at all times act reasonably and prudently. This behavior is especially important during emergencies.

All sports programs must have a prearranged emergency action plan (EAP) developed inconjuntion with emergency medical services (EMS) that can be implemented immediately when necessary.[3,34,38] See *Focus Box 8–1*. The following issues must be addressed when developing the emergency action plan:

Time becomes critical in an emergency situation.

All sports programs must have an emergency action plan.

It must be reemphasized that **athletic trainers, coaches, and others in areas related to exercise and sports science should be trained and certified in cardiopulmonary resuscitation (CPR), the use of an automated external defibrillator (AED), and first aid.** The extent of what they can and cannot do legally is determined by the laws and statutes of different states.[16] Much of the information contained in this Chapter is intended for informational purposes only and is in no way meant to encourage individuals to act outside of the scope of their responsibilities.

The Emergency Action Plan

The prime concern of emergency aid is to maintain cardiovascular function and, indirectly, central nervous system function, because failure of any of these systems may lead to death.[11,18] Regardless of the setting, whether on an athletic field or in a clinic, hospital, or fitness center, an emergency action plan should be developed for every venue in which an athletic trainer works.[38] The key to emergency aid in the sports setting is the initial evaluation of the injured athlete. Time is of the essence, so this evaluation must be done rapidly and accurately so that proper aid can be rendered without delay.[18] In some instances, these

1. Develop separate emergency action plans for each sport's field, courts, or gymnasiums.[40]
   a. Determine the personnel who will be on the field during practices and competitions (e.g., athletic trainers, athletic training students, physicians, emergency medical technicians, rescue squad). Each person should understand exactly what his or her role and responsibility is if an emergency occurs. It is also recommended that the sports medicine team practice the use and operation of emergency equipment, such as stretchers and automated external defibrillators (AED). **Everyone involved should know the location of the nearest AED for each venue.**[45]
   b. Decide what emergency equipment should be available for each sport. The emergency equipment needs for football will likely be different from those of the cross-country team.
2. Establish specific procedures and policies regarding the removal of protective equipment, particularly the helmet and shoulder pads.[15] These procedures will be discussed later in this Chapter.
3. Make sure phones are readily accessible. Wireless phones or satellite phones are easily

Focus Box 8–1

Sample emergency action plan

Emergency action plan for women's ice hockey

Emergency Personnel

Certified athletic trainer and athletic training students on-site for practice and competition: additional sports medicine staff accessible from main athletic health care facility (across street from arena)

Emergency Communication

Fixed telephone line in ice hockey satellite athletic health care facility (_____-_____)

Emergency Equipment

Supplies (AED, trauma kit, splint kit, spine board) maintained in ice hockey satellite athletic health care facility; additional emergency equipment accessible from athletic health care facility across street from arena (_____-_____)

Roles of First Responders

Immediate care of the injured or ill student athlete

Emergency equipment retrieval

Activation of emergency medical system (EMS)

911 call (provide name, address, telephone number; number of individuals injured; condition of injured; first-aid treatment; specific directions; other information as requested)

Direct EMS to scene

Open appropriate doors

Designate individual to "flag down" EMS and direct to scene

Scene control: Limit scene to first-aid providers and move bystanders away from area

Venue Directions

Ice hockey arena is located on corner of _____ _____ Street and _____ Street adjacent to_____. Two gates provide access to the arena: _____ Street; drive leads to arena as well as rear door of complex (locker room, athletic training room)

Sports Medicine Staff and Phone Numbers

Athletic Trainer in Charge	929-0000 (mobile)
Head Athletic Trainer	929-0001 (office)
Team Physician	929-0002 (office)

available and accessible. However, a land line should also be easily accessible, just in case cell phone service is not available. If wireless phones are not available, all staff personnel and athletes should know the location of the telephone; phones should be clearly marked. Use 911 if available, but realize that in some areas all service is not accessible by wireless phones, and thus land lines should be used to access the emergency medical system. Occasionally, calls made on cell phones may be redirected out of the local area. Thus, it is critical to ask what area the local 911 call has been directed to.

4. All staff should be familiar with the community-based emergency health care delivery plan, including existing communication and transportation policies.[26] It is also critical to be familiar with emergency care facility admission and treatment policies, particularly when rendering emergency care to a minor.[38] Someone should specifically be designated to make an emergency phone call. Most emergency medical systems can be accessed by dialing 911, which connects the caller to a dispatcher who has access to rescue squad, police, and fire personnel. The person making the emergency phone call must provide the following information:
   a. Type of emergency situation
   b. Type of suspected injury
   c. Present condition of the patient
   d. Current assistance being given (e.g., cardiopulmonary resuscitation)
   e. Location of telephone being used
   f. Exact location of emergency (give names of streets and cross streets) and how to enter facility
5. Make sure keys to gates or padlocks are easily accessible. Staff members should have the appropriate keys.
6. Inform all staff and maintenance personnel of the emergency plan at a meeting held annually before the beginning of the school year. Each individual must know his or her responsibilities should an emergency occur.
7. Assign someone to accompany the injured athlete to the hospital.
8. Carry contact information for all athletes, coaches, and other personnel in your cell phone, particularly when traveling. For minors, medical consent forms for medical treatment should also be available when traveling.
9. In certain situations at both secondary schools and colleges, staff members may be called upon to provide emergency services not only to athletes but also to coaches, referees, and in some cases parents and other spectators who may develop an emergent condition during the course of an athletic event. The emergency action plan should include plans for managing these situations with the help of emergency medical services and other local health care providers.[26] *Focus Box 8–1* provides an example of an emergency action plan.
10. A "time-out" should be used to have all of the individuals who will be involved with any aspect of athletic health care for that specific event meet to go over a checklist for that venue's emergency action plan to make certain that all parties involved are prepared to handle an emergency to ensure a decisive and coordinated response and outcome.[27]

Cooperation Between Emergency Care Providers

Individuals providing emergency care to the injured athlete must cooperate and act professionally.[26] Too often, the rescue squad personnel, a physician, an athletic trainer, or a coach disagree over exactly how the injured athlete should be handled and transported. The coach or athletic trainer is usually the first individual to deal with the emergency situation. The athletic trainer has generally had more training and experience in moving and transporting an injured athlete than the physician has. **If an athletic trainer or physician is not available, the rescue squad should be called to handle an emergency situation.**[16] If the rescue squad is called and responds, the emergency medical technicians (EMTs) should have the final say on how the athlete is to be transported in accordance with their established protocols.

To alleviate potential conflicts, it is a good idea to establish procedures and guidelines and to arrange practice sessions at least once a year, with all parties concerned, for handling the injured athlete. The rescue squad may not be experienced in dealing with someone who is wearing a helmet or other protective equipment. Before an incident occurs, the EMTs should understand how athletes wearing various types of athletic equipment should be managed. When dealing with the injured athlete, all egos should be put aside. Certainly, the most important consideration is what is the best for the athlete.

Parent Notification

According to HIPAA regulations discussed in Chapter 2, if the injured athlete is a minor, it is essential that actual consent to treat the athlete be obtained from the parent. **Actual consent should be obtained in writing from the parent or guardian prior to the beginning of the season.**[38] Actual consent is notification that the parent has been informed about what medical personnel thinks is wrong and what they

intend to do, and parental permission is granted to give treatment for a specific incident. If the athlete's parents cannot be contacted, then the predetermined wishes of the parent, given at the beginning of a season or school year, can be acted upon. If there is no informed consent, then implied consent on the part of the athlete to save his or her life takes precedence. *Focus Box 8–2* provides an example of a parental consent form for medical treatment of a minor.

Principles of On-The-Field Injury Assessment

Appropriate medical care cannot be delivered to the injured athlete until some systematic assessment of the situation has been made. This assessment (Figure 8–1) helps to determine the nature of the injury and provides direction in the decision-making process concerning the emergency care that must be rendered. The **primary survey** refers to assessment of potentially life-threatening problems including airway, breathing, circulation, severe bleeding, or shock. It takes precedence over all other aspects of victim assessment and should be used to correct life-threatening situations.[20] Once the condition of the victim is stabilized, the **secondary survey** is used to take a closer look at the injury sustained by the athlete. The secondary survey gathers specific information about the injury from the athlete, systematically assesses vital signs and symptoms, and allows for a more detailed evaluation of the injury. The secondary survey is done to uncover additional problems in other parts of the body not necessarily associated with the injury, which do not pose an immediate threat to life but which may do so if they remain uncorrected.[20] For example, an athlete with a concussion should also be evaluated for injury to the cervical spine.

An injured athlete who is conscious and stable does not require a primary survey. However, the unconscious athlete must be monitored for life-threatening problems throughout the assessment process.

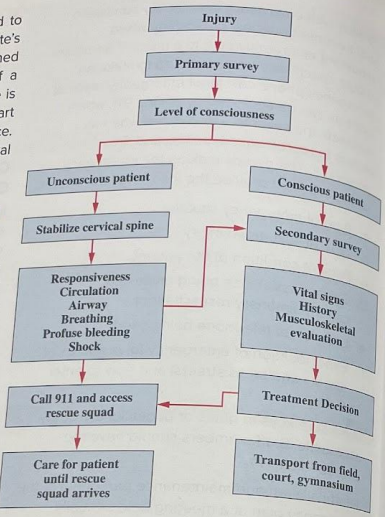


FIGURE 8–1 Flowchart showing the appropriate emergency procedures for the injured patient.

Focus Box 8–2

Consent form for medical treatment of a minor

By this signature, I hereby consent to allow the physician(s) and other health care provider(s) selected by myself or the school to perform a preparticipation examination on my child and to provide treatment for any injury or condition resulting from participating in athletics and activities for his or her school during the school year covered by this form. I further consent to allow said physician(s) or health care provider(s) to share appropriate information concerning my child that is relevant to participation in athletics and activities with coaches and other school personnel as deemed necessary.

_____ _____

Parent or Guardian Date

Primary Survey

Treatment of Life-Threatening Injuries

Life-threatening injuries take precedence over all other injuries sustained by the athlete. Situations that are considered life threatening include those that require CPR (i.e., no circulation, obstruction of the airway, no breathing), profuse bleeding, and shock. **Whenever there is a life-threatening situation, the rescue squad should always be called by dialing 911.**

The Unconscious Athlete

The state of unconsciousness provides one of the greatest dilemmas in sports. **With an unconscious athlete, the rescue squad should always be accessed by dialing 911, regardless of whether the situation is life threatening.** Unconsciousness may be defined as a state of insensibility in which there is a lack of conscious awareness. This condition can be brought about by a blow to either the head or the solar plexus, or it may result from general shock. It is often difficult to determine the exact cause of unconsciousness.

The unconscious athlete must always be considered to have a life-threatening injury, which requires an immediate primary survey. Here are guidelines that should be followed when dealing with the unconscious athlete:

1. The body position should be noted immediately, and the level of consciousness and responsiveness determined.
2. Circulation, airway, and breathing (CAB) should routinely be established immediately.[1]
3. Injury to the neck and cervical spine is always a possibility in the unconscious athlete.
4. Rescuers should immediately expose the airway by removing any protective equipment such as the face mask, helmet and shoulder pads that could interfere with CPR.
5. If the patient is supine and breathing, monitor closely until he or she regains consciousness.
6. If the patient is prone and not breathing, he or she should be logrolled carefully to the supine position, and CPR should begin immediately.
7. If the patient is prone and breathing, monitor closely until he or she regains consciousness; then the patient should be carefully logrolled onto a spine board because CPR could be necessary at any time.
8. Life support for the unconscious patient should be maintained and monitored until emergency medical personnel arrive.
9. Once the patient is stabilized (no longer exhibits a life-threatening condition), the athletic trainer should begin a secondary survey.

Overview of Emergency Cardiopulmonary Resuscitation (CPR)

It is essential that a careful evaluation of the injured athlete be made to determine whether CPR is necessary (Figure 8–2). **All individuals that are in any way associated with a competitive or recreational sports program should be certified and maintain certification in CPR, AED, and first aid by the American Red Cross, the American Heart Association, or the National Safety Council.**[1,2,29] Athletic trainers should routinely be recertified in CPR/AED for the Professional Rescuer.

Anyone providing care in an emergency situation that will require CPR should be aware that the Good Samaritan Laws were enacted to give legal protection to individuals who voluntarily provide emergency care to an injured victim. However, athletic trainers have a "duty to act" given the nature of their job. They

8–1 Critical Thinking Exercise

A football defensive back is making a tackle and on contact drops his head to tackle the ball carrier. He hits the ground and does not move. The athlete is lying prone, is unconscious, but is breathing.

How should this situation be managed?

FIGURE 8–2 Everyone should be certified and prepared to perform CPR should it be necessary.

are responsible to the athlete and thus must be willing to provide CPR should it be necessary. It is recommended that a first-aid care provider obtain consent from the victim before rendering first aid. However, in the case of an unconscious individual who requires CPR, consent would be implied, meaning that the person would give consent if he or she could.[2]

In 2008, the American Heart Association proposed changes that simplified CPR techniques for those people who have *not* been certified in CPR.[1] This technique, referred to as "hands-only CPR," only requires a rescuer to call 911, then to perform uninterrupted chest compressions—100–120 a minute—until paramedics take over or an automated external defibrillator is available to restore a normal heart rhythm. If an **Automated External Defibrillator (AED)** is available it should be used immediately after it has been determined that the victim is unresponsive. If not it should be used as soon as it becomes available. (Figure 8–3) This action should be taken only for adults who unexpectedly collapse, stop breathing, and are unresponsive.[1]

FIGURE 8–3 If available, an automated external defibrillator (AED) should be used.

In 2015, the American Heart Association changed its acronym of **ABC** to **CAB**—circulation, airway, breathing—to help individuals who are certified in CPR remember the order of the procedures.[1] This change emphasized the importance of chest compressions in creating circulation. *Focus Box 8–3* (CPR Summary) summarizes the most recent (2015) guidelines for performing CPR for the adult, child, and infant.

Focus Box 8–3

CPR summary

For individuals certified in CPR:

For an Adult

- Establish unresponsiveness.
- Look for no breathing and check pulse (<10 seconds)
- If an AED is available, deliver one shock if instructed by the device, and begin CPR.
- Restore blood circulation using chest compressions at a rate of 100–120 per minute.
  - Perform 30 compressions.
  - Use two hands for compression.
  - Compress the chest at least 2 inches.
- Perform mouth-to-mouth breathing after opening the airway.
  - Give two breaths (one second per ventilation).
  - Breathe until the chest rises.
  - Resume chest compressions.
- After five cycles or 2 minutes with no response, use an automated external defibrillator (AED) (Figure 8–3).
  - Administer one shock if instructed by the device, and then continue CPR.
- Continue CPR until the person begins to breathe or EMS takes over.

For a Child (Ages 1–8)

- Establish unresponsiveness, and then call 911.
- Look for no breathing and check pulse (<10 seconds)
- Restore blood circulation using chest compressions at a rate of 100 per minute.
  - Perform 30 compressions.
  - Use two hands for compressions.
  - Compress the chest about 1½ inches.
- Perform mouth-to-mouth breathing after opening the airway.
  - Give two breaths (one second per ventilation).
  - Breathe more gently than for an adult until the chest rises.
  - Resume chest compressions.
- After five cycles or 2 minutes with no response, use an automated external defibrillator (AED).
  - Use pediatric pads if available.
  - Administer one shock if instructed by the device, and then continue CPR.
  - Call 911.
- Continue CPR until the child begins to breathe or EMS takes over.

For an Infant

- Establish unresponsiveness, and then call 911.
- Restore blood circulation with chest compressions at a rate of 100 per minute.
  - Perform 30 compressions.
  - Use two fingers on sternum just below nipple line for compressions.
- Perform mouth-to-mouth/nose breathing after opening the airway.
  - Give two breaths.
  - Breathe more gently than for an adult.
  - Resume chest compressions.
- After five cycles or 2 minutes with no response, reassess.
- Continue CPR until the child begins to breathe or EMS takes over.

For Individuals Who Are Not Certified in CPR

- Perform chest compressions only, at a rate of 100 per minute continuously until EMS arrives.

Controlling Bleeding

An abnormal external or internal discharge of blood is called a **hemorrhage**.[20] The hemorrhage may be venous, capillary, or arterial and may be external or internal. Venous blood is characteristically dark red with a continuous flow, capillary bleeding exudes from tissue and is a reddish color, and arterial bleeding flows in spurts and is bright red. NOTE: The athletic trainer must always be concerned with exposure to bloodborne pathogens and other diseases when coming in contact with someone's blood or other body fluids. It is essential to take *universal precautions* to minimize this risk. Disposable nonlatex gloves should be used routinely whenever anyone comes in contact with blood or other bodily fluids. This topic is discussed in detail in Chapter 9.

Controlling External Bleeding External bleeding stems from open skin wounds such as abrasions, incisions, lacerations, punctures, or avulsions. The control of external bleeding is most effectively accomplished by use of direct pressure. Elevation and pressure points may also help to control bleeding.[28]

Direct Pressure Pressure applied directly over a wound with the hand over a sterile gauze pad is now recommended as the primary technique for controlling bleeding.[44] The pressure is applied firmly against the resistance of a bone unless there is an underlying fracture (Figure 8–4). As a gauze pad becomes soaked, additional pads should be placed on top of those already in place to facilitate the clotting process. Pressure may also be applied with a compression bandage holding sterile gauze in place over the wound.

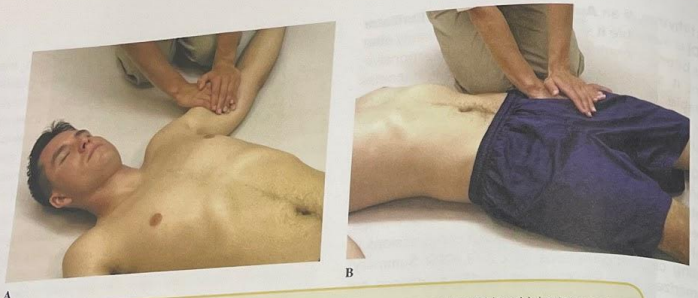
FIGURE 8–4 Direct pressure for the control of bleeding is applied with the hand over a sterile gauze pad.

Elevation Elevation provides an additional means for the reduction of external hemorrhage. Elevating a hemorrhaging part against gravity reduces blood pressure and facilitates venous and lymphatic drainage; consequently, elevating slows bleeding.[35]

External bleeding can usually be managed by using direct pressure, elevation, or pressure points.

Pressure Points When direct pressure combined with elevation fails to slow hemorrhage, the use of pressure points may be the method of choice.[20] Eleven points on each side of the body have been identified for controlling external bleeding; the two most commonly used are the brachial artery in the upper limb and the femoral artery in the lower limb. The brachial artery is compressed against the medial aspect of the humerus, and the femoral artery is compressed as it is detected within the femoral triangle (Figure 8–5).

Internal Hemorrhage Internal hemorrhage is invisible to the eye unless manifested through some body opening or identified through X-ray studies or other diagnostic techniques. Its danger lies in the difficulty of diagnosis. When internal hemorrhaging occurs, subcutaneously such as in a bruise or contusion, or intramuscularly, or in joints, the athlete



A B

FIGURE 8–5 The two most common sites for pressure points are the **(A)** brachial artery and **(B)** the femoral artery.

may be moved without danger in most instances. However, the detection of bleeding within a body cavity such as the skull, thorax, or abdomen is of the utmost importance because it could mean the difference between life and death. Because the symptoms are obscure, internal hemorrhage is difficult to diagnose properly. As a result of this difficulty, **athletes with internal injuries require hospitalization under complete and constant observation by a medical staff to determine the nature and extent of the injuries.** All severe hemorrhaging eventually results in shock and should therefore be treated on this premise. Even if there is no outward indication of shock, the athlete should be kept quiet and body heat should be maintained at a constant and suitable temperature (see the section on shock for the preferred body position).[28]

Managing Shock

With any injury **shock** is a possibility. But when severe bleeding, fractures, or internal injuries are present, the potential for shock increases. Shock occurs when a diminished amount of blood is available to the circulatory system. As a result, not enough oxygen-carrying blood cells are available to the tissues, particularly those of the nervous system. When shock occurs, a quantity of plasma is lost from the blood vessels to the tissue spaces of the body, leaving the blood cells within the vessels, thus slowing the blood flow. This general collapse of the vascular system causes widespread tissue death, which eventually causes the death of the individual unless treatment is given.[37]

Certain conditions such as extreme fatigue, exposure to extreme heat or cold, extreme dehydration and mineral loss, or illness predispose an athlete to shock. In a situation with potential for a shock condition, the athletic trainer or coach should use other signs to assess the possibility of the athlete's lapsing into a state of shock as an aftermath of the injury. The most important clue to potential shock is the recognition of a severe injury. It may happen that none of the usual signs of shock is present.[2,4]

Symptoms and Signs The major signs of shock are moist, pale, cool, clammy skin; weak and rapid pulse; increased and shallow respiratory rate; decreased blood pressure; and in severe situations urinary retention and fecal incontinence. If conscious, the athlete may display a disinterest in his or her surroundings or may display irritability, restlessness, or excitement. There may also be extreme thirst.[20]

Signs of shock:
- Blood pressure is low.
- Systolic pressure is usually below 90 mm Hg.
- Pulse is rapid and very weak.
- Athlete may be drowsy and appear sluggish.
- Respiration is shallow and extremely rapid.
- Athlete's skin is pale, cool, clammy.

Management Depending on the causative factor for the shock, the following emergency care should be given:

1. Dial 911 to access emergency care.
2. Maintain body temperature as close to normal as possible.
3. Elevate the feet and legs 8 to 12 inches for most situations. However, shock positioning varies according to the type of injury.[37] For example, for a neck injury, the athlete should be immobilized as found; for a head injury, his or her head and shoulders should be elevated; and for a leg fracture, his or her leg should be kept level and should be raised after splinting.

Shock can also be compounded or initially produced by the psychological reaction of the athlete to an injury situation. Fear or the sudden realization that a serious situation has occurred can result in shock. In the case of a psychological reaction to an injury, the athlete should be instructed to lie down and avoid viewing the injury. This athlete should be handled with patience and gentleness, but firmness as well. Spectators should be kept away from the injured athlete. Reassurance is of vital concern to the injured individual. The person should be made comfortable by loosening his or her clothing. Nothing should be given by mouth until a physician has determined that no surgical procedures are indicated.

Secondary Survey

If the athlete has no life-threatening injuries, a secondary survey should be conducted to assess the entire body for injury.

Recognizing Vital Signs

Anyone providing emergency care has to be able to evaluate the existing physiological signs and symptoms of injury. Among these **vital signs** are heart rate, breathing rate, blood pressure, temperature, skin color, pupils of the eye, movement, the presence of pain, and level of consciousness. **It is important to be able to recognize when one or more of the vital signs does not appear to be normal.** Table 8–1 provides a list of what is considered to be normal with each of these vital signs. An individual with any abnormal vital sign should be referred to a physician.

Vital signs to observe:
- Level of consciousness
- Pulse
- Respiration
- Blood pressure
- Temperature
- Skin color
- Pupils
- Movement
- Abnormal nerve response

On-Field Injury Inspection

Two phases of injury assessment take place during the secondary evaluation. The first involves the initial on-field injury inspection during which early decisions are made relative to (1) the seriousness of the injury and (2) how the injured athlete should be transported from the playing field. The more thorough off-field assessment is usually done by either the athletic trainer or a physician, if necessary.

A logical process must be used to evaluate accurately the extent of a musculoskeletal injury.[21] It is critical to be aware of the major signs that reveal the site, nature, and above all, severity of the injury. Detection of these signs can be facilitated, as is true with all trauma, by understanding the mechanism or traumatic sequence and by methodically inspecting the injury. Knowledge of the mechanism of an injury is extremely important in determining which area of the body is most affected.

Some athletes normally have irregular and unequal pupils.

TABLE 8–1 VITAL SIGNS

Sign	Description
Level of consciousness	Normally the athlete is alert, is aware of the environment, and responds quickly to vocal stimulation.
Pulse	Normal pulse rate per minute for adults ranges between 60 and 80 beats and in children from 80 to 100 beats. Trained athletes usually have slower pulse rates. Pulse rate is measured at the carotid artery in the neck or the radial artery in the wrist (Figure 8–6).
Respiration	Normal breathing rate per minute is approximately 12 breaths in adults and 20 to 25 breaths in children. Breathing may be shallow (indicating shock), irregular, or gasping (indicating cardiac involvement).
Blood pressure	Normal systolic pressure for 15- to 20-year-old males ranges from 100 to 140 mm Hg. The diastolic pressure, on the other hand, usually ranges from 60 to 90 mm Hg. The normal blood pressure of females is usually 8 to 10 mm Hg lower than in males for both systolic and diastolic pressures. Blood pressure can only be measured using a blood pressure cuff and a stethoscope (Figure 8–7).
Temperature	Normal body temperature is 98.6° F (37° C). Core temperature is most accurately measured in the rectum or at the tympanic membrane in the ear (Figure 8–8).
Skin color	Red skin may indicate heatstroke, high blood pressure, or elevated temperature. Pale, ashen, or white skin can mean insufficient circulation, shock, fright, hemorrhage, heat exhaustion, or insulin shock. Blue skin (cyanotic), primarily noted in lips and fingernails, usually means an airway obstruction or respiratory insufficiency.
Pupils	Pupils should be of equal size. Pupil should respond to light, resulting in constriction or dilation. Response is more critical than pupil size (Figure 8–9).
Weakness of movement	Weakness of one side of the body compared to the other is not normal and may indicate nerve damage.
Sensory changes	Numbness, tingling, or complete loss of sensation is not normal.

In an attempt to understand the mechanism of injury, a brief history of the complaint must be taken. The athlete is asked, if possible, about the events leading up to the injury and how it occurred. The athlete is further asked what was heard or felt when the injury took place. Such sounds as a snap, crack, or pop at the moment of injury often indicate bone fracture or injury to ligaments or tendons. A visual observation of the injured site is made, comparing it to the uninjured body part. The initial visual examination can disclose obvious deformity, swelling, and skin discoloration.

Finally, the region of the injury is gently palpated. Feeling, or palpating, a part can, in conjunction with visual and audible signs, indicate the nature of the injury. Palpation is started away from the injury and gradually moved toward it. The extent of point tenderness, the extent of irritation (whether it is confined to soft tissue alone or extends to the bony tissue), and deformities that may not be detected by visual examination alone can be determined through palpation.

8–2 Critical Thinking Exercise

A recreational tennis player complains of pain in his shoulder that he has had for about a week. He indicates that he first hurt the shoulder when lifting weights but did not think it was a bad injury. During the past week he has not been able to lift because of pain. He has, however, continued to play but his shoulder seems to be getting worse instead of better.

What is the process for evaluating this injury?

Decisions that can be made from the secondary survey:

- Seriousness of injury
- Type of first aid required
- Whether injury warrants referral to a physician
- Type of transportation needed

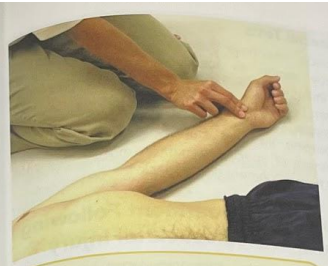


FIGURE 8–6 Pulse rate can be taken at the radial artery.

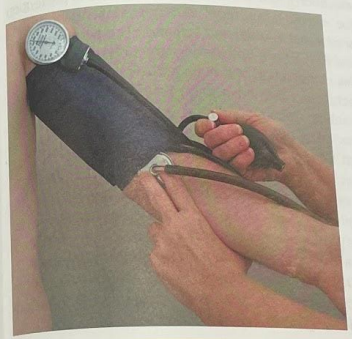


FIGURE 8–7 Blood pressure is measured using a sphygmomanometer and a stethoscope.

FIGURE 8–8 Thermometer for measuring tympanic membrane temperature.

FIGURE 8–9 The pupils of the eyes are extremely sensitive to situations affecting the nervous system **(A)** Constricted, **(B)** Normal, **(C)** Dilated.

3. Whether the injury warrants immediate referral to a physician for further assessment.
4. The manner of athlete transportation from the injury site to the sidelines, athletic training room, or hospital.

It is important to document in written form the findings of the on-the-field exam. This should be done as soon after evaluating the injury as practical to ensure accuracy in reporting what was found during the evaluation and the course of action taken.

Off-Field Assessment

A more thorough off-field evaluation is performed by an athletic trainer, a physical therapist, or a physician once the athlete has been removed from the site of initial injury to a place of comfort and safety.[21] This detailed assessment may be performed on the

After the brief on-field injury inspection, the following decisions should be made:

1. The seriousness of the injury.
2. The type of first aid and immobilization necessary.

Off- field assessment consists of:

- History
- Observation
- Physical examination
- Special tests

sidelines, in an emergency room, in the athletic health care facility, or in a sports medicine clinic. The evaluation scheme is divided into four broad categories: history, observation, palpation (physical examination) and special tests **(HOPS)**. Numerous special tests can provide additional information about the extent of injuries. The following discussion provides a brief overview of some of the steps and techniques that can be used in an off-field assessment.

History

Obtaining as much information as possible about the injury is of major importance. Understanding the mechanism of injury, how the injury occurred, if there is a previous history of this injury, and listening to the complaints of the athlete and how key questions are answered can provide important clues to the exact nature of the injury. The examiner becomes a detective in pursuit of as much accurate information as possible, which will lead to a determination of the true nature of the injury. From the history the examiner develops strategies for further examination and possible immediate and follow-up management.

Observation

Along with gaining knowledge and understanding of the athlete's major complaint from a history, general observation is also performed, often at the same time the history is taken. Observation should include looking for swelling and edema, deformity, discoloration, and tissue temperature changes.

Palpation

Palpation should include both bones and soft tissues. As with all examination procedures, palpation must be performed systematically, starting with very light pressure followed by gradually deeper pressure and usually beginning away from the site of complaint, then gradually moving toward it.

Special Tests

Special tests have been designed for almost every body region as means for detecting specific pathologies. They are often used to substantiate what has been learned from other testing. For example, special tests are commonly used to determine ligament stability, impingement signs, tightness of specific structures, muscle imbalance, and body alignment discrepancies.

Immediate Treatment Following Acute Musculoskeletal Injury

For many years the recommendation for managing acute musculoskeletal injuries has included the immediate application of ice, compression, and elevation in combination with some type of protection (i.e. elastic wrap, tape, crutches, walking boot etc.) and/or rest or restricted activity.[4,5] The acronyms *RICE* and *PRICE* have both been commonly used to refer to this combination of simultaneously applied treatment techniques that have been well-accepted as a best practice recommendation by most health care providers. Most recently, it has been recommended that a more appropriate acronym would be **POLICE** which stands for protection, optimal loading, ice, compression, and elevation.[6] If swelling can be minimized initially, the amount of time required for injury rehabilitation will be significantly reduced. Initial management of musculoskeletal injuries should include **POLICE.** *Focus Box 8–4* summarizes the specific technique for initial management of acute injuries (Figure 8–10).

Protection

Protection from further injury should occur immediately following injury. If there is a fracture or some joint instability, the injured structure should be immobilized with some type of splint or brace.[6]

POLICE (protection, optimal loading, ice, compression, elevation) are essential in the emergency care of musculoskeletal injuries.

Focus Box 8–4

Initial management of acute injuries

The appropriate technique for initial management of the acute musculoskeletal injury, regardless of where it occurs, is the following:

1. Apply a compression wrap directly over the injury. Wrapping should start distally and continue proximally. Tension should be firm and consistent. It may be helpful to wet the elastic wrap to facilitate the passage of cold from ice packs. After the compression wrap is applied, check the area distal to the wrap for circulation. A dry compression wrap should be left in place for at least 72 hours or until there is little chance of continued swelling.
2. Surround the injured area entirely with ice packs or bags and secure them in place. The ice should be left on for 20 minutes initially and then 1 hour off and 30 minutes on as much as possible over the next 24 hours. During the following 48-hour period, ice should again be applied as often as possible.
3. The injured part should be elevated for most of the initial 72-hour period after injury. It is particularly important to keep the injury elevated while sleeping. The end of the mattress can be elevated by placing pillows or a rolled-up blanket underneath. This elevation also allows the damaged part to rest after the injury. The initial management of an injury is extremely important to reduce the length of time required for rehabilitation.

Choosing an appropriate method of transporting the injured athlete from the field can also help to protect an injury from further damage.

Optimal Loading

Optimal loading refers to determining and subsequently incorporating the appropriate progression from protecting the tissue to prevent exacerbation of the injury, to mechanically loading the tissue to facilitate healing. Early functional activity encourages early recovery. Longer periods of rest during which injured tissues are unloaded may produce adverse changes to joints and tissues. Progressive mechanical loading of injured tissues following acute injury facilitates healing.[8]

Ice (Cold Application)

The initial treatment of acute injuries should use cold.[35] Therefore ice is used for most conditions involving strains, sprains, and contusions. Ice is most commonly used immediately after injury to decrease pain and promote local constriction of the vessels (vasoconstriction), thus controlling hemorrhage and edema.[7,19] Cold applied to an acute injury lowers metabolism and the tissue demands for oxygen, and reduces hypoxia.[24] With ice treatments, the athlete usually reports an uncomfortable sensation of cold, followed by burning, then an aching sensation, and finally complete numbness.

Because subcutaneous (under the skin) fat conducts cold slowly, applications of cold for short periods are ineffective in cooling deeper tissues. For this reason, treatments of at least 20 minutes are recommended. Prolonged application of cold, however, can cause tissue damage.[18]

FIGURE 8–10 POLICE technique: **(A)** A wet compression wrap should be applied over the horseshoe pad; **(B)** ice bags should be secured in place by a dry compression wrap; and **(C)** the leg should be elevated against the wall during the initial treatment period.

Ice packs should be applied to the area for at least 72 hours after an acute injury. With many injuries, regular ice treatments may be continued for several weeks.

For best results, ice packs (crushed ice and towel) should be applied over a compression wrap (Figure 8–10B). Frozen gel packs should not be used directly against the skin, because they reach much lower temperatures than ice packs. A good rule of thumb is to apply a cold pack to a recent injury for a 20-minute period and repeat every 1 to 1½ hours throughout the waking day. Depending on the severity and site of the injury, cold may be applied intermittently for 1 to 72 hours. For example, a mild strain will probably require 1 day of 20-minute periods of cold application, whereas a severe knee or ankle sprain might need 3 to 7 days of intermittent cold. If in doubt about the severity of an injury, it is best to extend the time that ice is applied.[35]

8–3 Critical Thinking Exercise

A field hockey player trips over an opponent's stick, turning her ankle inward, and falls to the turf, sustaining a grade 2 ankle sprain. She has immediate swelling and significant pain, and on examination, there appears to be some laxity in the ankle joint.

What specifically should be done to most effectively control the initial swelling associated with this injury?

Compression

Immediate compression of an acute injury is perhaps more important than ice in controlling swelling.[19] *Placing external pressure on an injury assists in decreasing hemorrhage and hematoma formation by mechanically reducing the space available for swelling to accumulate. Fluid seepage into interstitial spaces is retarded by compression, and absorption is facilitated. However, application of compression to an anterior compartment syndrome or to certain injuries involving the head and neck is contraindicated.*

Many types of compression are available. An elastic wrap that has been soaked in water and frozen in a refrigerator can provide both compression and cold when applied to a recent injury. Pads can be cut from felt or foam rubber to fit difficult-to-compress body areas. A horseshoe-shaped pad, for example, placed around the malleolus in combination with an elastic wrap and tape provides an excellent way to prevent or reduce ankle edema (Figure 8–10A). Although cold is applied intermittently, compression should be maintained throughout the day and, if possible, throughout the night. Pressure buildup in the tissues may make it painful to leave a compression wrap in place for a long time. However, the wrap must be left in place even though there may be significant discomfort because compression is so important in the control of swelling. The compression wrap should be left in place for at least 72 hours after an acute injury. In many chronic overuse problems, such as tendonitis, tenosynovitis, and particularly bursitis, the compression wrap should be worn until swelling is almost entirely gone.

Elevation

Along with cold and compression, elevation reduces internal bleeding. The injured part, particularly an extremity, should be elevated to eliminate the effects of gravity on blood pooling in the extremities. Elevation assists the veins, which drain blood and other fluids from the injured area and return them to the central circulatory system. The greater the degree of elevation, the more effective the reduction in swelling. For example, in an ankle sprain the leg should be placed so that the ankle is virtually straight up in the air against the wall. The injured part should be elevated as much as possible during the first 72 hours (Figure 8-10C).

Emergency Splinting

If an athlete appears to have a fracture, dial 911 to access the rescue squad immediately. Any suspected fracture should be splinted before the athlete is moved.[31] *If EMS is on the way, it is best to make use of the ground to splint the fracture. There is no point in moving the athlete immediately when the paramedics are likely to move him or her again to apply their splints. Transporting a person with a fracture without proper immobilization can result in increased tissue damage, hemorrhage, and shock. The application of splints should be a simple process through the use of commercial emergency splints.*

A suspected fracture must be splinted before the athlete is moved.

Regardless of the type of splint used, the principles of good splinting remain the same. Two major concepts of splinting are (1) to splint from one joint above the fracture to one joint below the fracture and (2) to splint the injury in the position it is found. If at all possible, do not move the athlete until he or she has been splinted.

Rapid Form Vacuum Immobilizers

The rapid form vacuum immobilizer is a type of splint that is widely used by both EMTs and athletic trainers. It consists of styrofoam chips contained inside an airtight cloth sleeve that is pliable. It can be molded to the shape of any joint or angulated fracture using Velcro straps. A handheld pump sucks the air out of the sleeve, giving it a cardboardlike rigidity. This splint is most useful for injuries that are angulated and must be splinted in the position in which they are found (Figure 8–11A).

A

B

FIGURE 8–11 **(A)** Rapid form vacuum immobilizer. **(B)** Air splint.

Air Splints

An air splint is a clear plastic splint that is inflated with air around the affected part; it can be used for extremity splinting, but its use requires some special training. This splint provides support and moderate pressure to the body part and affords a clear view of the site for X-ray examination. The inflatable splint should not be used if it will alter a fracture deformity (Figure 8–11B).

Splinting of Lower-Limb Fractures

Fractures of the ankle or leg require immobilization of the foot and knee. Any fracture involving the knee, thigh, or hip needs splinting of all the lower-limb joints and one side of the trunk.

Splinting of Upper-Limb Fractures

Fractures around the shoulder complex are immobilized by a shoulder sling, with the upper limb bound to the body securely. Upper-arm and elbow fractures must be splinted in the position they are found. Lower-arm and wrist fractures should be splinted in a position of forearm flexion and should be supported by a sling. Hand and finger dislocations and fractures should be splinted with tongue depressors, gauze rolls, or aluminum splints.

Splinting of the Spine and Pelvis

Injuries involving a possible spine or pelvic fracture are best splinted and moved using a spine board (see Figure 8–14).

Moving and Transporting The Injured Athlete

Moving, lifting, and transporting the injured athlete must be executed using techniques that prevent further injury. Moving or transporting the athlete improperly may cause additional injuries than any other emergency procedure.[20] *There is no excuse for poor handling of the injured athlete. Planning should take into consideration all the possible transportation methods and the necessary equipment to execute them. Capable and well-trained personnel, spine boards, stretchers, and a rescue vehicle may be needed to transport the injured athlete.*

Suspected Cervical Spinal Injury

When injury to the cervical spine is suspected, immediately dial 911 to access the EMS, then work

closely with EMS personnel in moving and transporting the injured patient. *After the rescue squad has been called, the athletic trainer should assume the responsibility for providing primary emergency care. Primary emergency care involves helping the patient maintain normal breathing, treating the patient for profuse bleeding or shock, and keeping the patient quiet and calm.*

A suspected cervical spine injury requires extremely careful handling and is best left to properly trained athletic trainers, paramedics, or EMTs who are well prepared and have access to the proper equipment for transport.[43] *Ideally, the patient with a suspected cervical spine injury should not be moved until a physician has examined the athlete and has given permission to move him or her. The most important principle in moving and transporting the injured patient is spinal motion restriction (SMR) to prevent further harm to the spinal cord by maintaining the head and neck in neutral alignment with the long axis of the body throughout the entire transport process.*[26] *There are two techniques that are recommended for stabilizing the cervical spine: the head-squeeze technique (Figure 8–12A), where the rescuer holds the sides of the head with both hands, and the trap-squeeze method (Figure 8–12B), where the rescuer grips the patient's trapezius muscles on either side of the neck and firmly squeezes the head between the forearms.*[15]

Equipment Considerations *Protective equipment worn by an athlete may complicate lifesaving CPR procedures. The presence of a football, ice hockey, or lacrosse helmet with a face mask and various types of shoulder pads associated with each sport obviously makes CPR more difficult if not impossible.*[47] *Thus, exposure and access to the airway and chest should CPR, and the use of an AED, be necessary must be established or easily achieved in a reasonable and acceptable manner.*[40]

Decisions to remove a facemask, helmet, and shoulder pads before initiating CPR should be based on the potential of injury to the cervical spine.[14] *For many years the recommendation was that the helmet should not be removed from an athlete with a suspected cervical spine injury.*[39] *However, most recently an inter-association task force composed of experts from multiple organizations has recommended that when appropriate, protective athletic equipment may be removed while maintaining cervical spine stabilization prior to transport to an emergency facility for a patient with suspected cervical spine instability.*[26] *Further, it is recommended that equipment removal be performed by at least three or four rescuers who have been trained and are experienced with equipment removal at the earliest possible time. If fewer than three people are present, the equipment should be removed as soon as possible after enough trained individuals arrive on the scene.*[26] *Individuals who are trained and experienced rescuers should be able to make a determination if there are existing circumstances in which equipment removal is not appropriate. The rationale for equipment removal is that these trained individuals on the field will likely have a greater knowledge of equipment removal procedures than the hospital emergency department staff.*[26] *After decades of controversy regarding the correct approach or sequence for removal of protective equipment in football, lacrosse, and ice hockey, it now appears that both the helmet and shoulder pads may be removed prior to transport.* (Figure 8–13).

A

B

FIGURE 8–12 Cervical spine stabilization techniques. **(A)** Head-squeeze technique, **(B)** Trap-squeeze technique.

FIGURE 8–13 Both the helmet and the shoulder pads should be removed prior to transporting the injured athlete to an emergency care facility.

If there is ANY possibility of injury to the cervical spine, care must be taken to minimize movement of the head and neck during and following removal of protective equipment. Thus a rigid cervical collar should be applied at the earliest and most appropriate time possible prior to transporting the injured athlete to an emergency care facility to maximize spinal motion restriction.[15] (Figure 8–14) It should be noted that rigid cervical collars do not completely control cervical spine motion but are more effective when combined with manual in-line cervical stabilization.

Placing the Athlete on a Spine Board Until recently the standard of care for cervical spine injured patients has been to place the patient on a rigid, long spine board for transport. However there are concerns over the length of time the patient is in discomfort from lying on the rigid, unyeilding board. The most current recommendation is to initially place the patient on a long spine board, scoop stretcher or vacuum mattress for extraction from the field or court and then transfer them, as soon as possible, to a less rigid stretcher for transport.[15,26]

If the patient is supine, an 8-person lift should be used to move the patient onto the long spine board using a lift and slide technique. (Figure 8–15)[40] The 8-person lift has been shown to be more effective in restricting motion in the head compared with the logroll technique.[15]

If the patient is prone, he or she must be logrolled onto his or her back to be placed on either a long spine board, a scoop stretcher, or a vacuum mattress.[30,32] (Figure 8–16) To logroll the patient requires a long spine board to be positioned at an angle of 45 degrees close to the patient's side. The patient is then logrolled and pushed onto the spine board while carefully maintaining the axial alignment of the trunk, the hips and thighs, and the lower legs. Once the patient is supine on the long spine board the helmet and should pads can be removed as described earlier and a rigid cervical collar should be applied immediately.

FIGURE 8–14 The cervical spine should be stabilized by applying a rigid cervical collar.

FIGURE 8–15 An eight-person lift should be used to move the injured patient onto the spineboard.

FIGURE 8–16 If the injured patient is lying prone they should be log-rolled to a supine position on a spineboard.

FIGURE 8–17 The injured patient should be secured to the spineboard using a) straps applied across the chest, hips, thighs, and lower legs and b)lateral restraint pads and straps to secure the head.

Once on the spine board the patient should be secured using spider straps applied across the chest, hips, thighs, and lower legs. (Figure 8–17A) Finally the head should be secured with lateral restraint pads and then secured to the spine board with tape over the chin and forehead. (8–17B)[40]

Until recently the standard of care for cervical spine–injured patients has been to place the patient on a rigid, long spine board for transport. However, concerns over the length of time the patient is in discomfort from lying on the rigid, unyielding board have led to recommendations that an injured athlete should be initially placed on a long spine board for extraction from the field or court and then transfered as soon as possible, to a less-rigid stretcher for transport.[15]

Stretcher Carrying

All rescuers place themselves in a position to stand, and then, on the command of the person stabilizing the cervical spine, they collectively lift and carry the patient on the spine board to a cart for removal from the field or to an emergency vehicle for transport to a hospital capable of delivering immediate, definitive care to a patient with a potential spinal cord injury. (Figure 8–18).[15] *Once the patient arrives at the hospital emergency department, the patient should be*

FIGURE 8–18 Whenever a serious injury is suspected, a stretcher is the safest method for transporting the athlete.

transferred off of the spine board to the appropriate hospital bed to prevent potentially detrimental effects related to a prolonged length of time on the spine board or scoop stretcher.[26] Any person with an injury serious enough to require the use of a stretcher must be carefully examined before being moved.

When transporting a person with a limb injury, be certain the injury is splinted properly before transport. Athletes with shoulder injuries are more comfortably moved in a semi-sitting position, unless other injuries preclude such positioning. If injury to the upper extremity is such that flexion of the elbow is not possible, the individual should be transported on a stretcher with the limb properly splinted and carried at the side and with adequate padding placed between the arm and the body.

Ambulatory Aid

Ambulatory aid (Figure 8–19) is support or assistance given to an injured athlete who is able to walk. Before the athlete is allowed to walk, he or she should be carefully scrutinized to make sure that the injuries are minor. Whenever serious injuries are suspected, walking should be prohibited. Complete support should be given on both sides of the athlete by two individuals who are approximately the same height. The athlete's arms are draped over the assistants' shoulders, and their arms encircle his or her back.

Manual Conveyance

Manual conveyance (Figure 8–20) may be used to move a mildly injured individual a greater distance than can be walked with ease. As with the use of

FIGURE 8–19 The ambulatory aid method of transporting a mildly injured athlete.

FIGURE 8–20 Manual conveyance method for transporting a mildly injured athlete.

ambulatory aid, any decision to carry the athlete must be made only after a complete examination to determine the existence of potentially serious conditions. The most convenient carry is performed by two assistants.

Fitting and Using the Crutch or Cane

When an athlete has a lower-limb injury, weight bearing may be contraindicated. Situations of this type call for the use of crutches or a cane. Very often, the athlete is assigned one of these aids without proper fitting or instruction in its use. Improper fit and usage can place abnormal stresses on various body parts. Constant pressure of the body weight on the crutch's axillary pads can cause crutch palsy. This pressure on the axillary or radial nerves and blood vessels can lead to temporary or even permanent numbness in the hands. Faulty mechanics in the use of crutches or canes can produce chronic low back and/or hip strain.

Fitting the Athlete The adjustable crutch is well suited to the athlete (Figure 8–21). For a correct fit, the athlete should wear low-heeled shoes and stand with good posture and the feet close together. The crutch length is determined first by placing the tip

FIGURE 8–21 The crutch must be properly fitted to the athlete. **(A)** The crutch tips are placed 6 inches from the outer margin of the shoe and 2 inches in front of the shoe. **(B)** The underarm crutch brace is positioned 1 inch below the anterior fold of the axilla. **(C)** The hand brace is placed even with the athlete's hand, with the elbow flexed approximately 30 degrees.

Properly fitting a crutch or cane is essential to avoid placing abnormal stresses on the body.

6 inches (15 cm) from the outer margin of the shoe and 2 inches (5 cm) in front of the shoe. The underarm crutch brace is positioned 1 inch (2.5 cm) below the anterior fold of the axilla. Next, the hand brace is adjusted so that it is even with the athlete's hand, and the elbow is flexed at approximately a 30-degree angle. Fitting a cane to the athlete is relatively easy. Measurement is taken from the superior aspect of the greater trochanter of the femur to the floor while the athlete is wearing street shoes.

Walking with Crutches or Cane Many elements of crutch walking correspond with walking. The technique commonly used in sports injuries is the tripod method. In this method, the athlete swings through the crutches without making any surface contact with the injured limb or by partially bearing weight with the injured limb. The following sequence is performed:

1. The athlete stands on one foot, with the affected foot completely elevated or partially bearing weight.
2. Placing the crutch tips 12 to 15 inches ahead of the feet, the athlete leans forward, straightens the elbows, pulls the upper crosspiece firmly against the side of the chest, and swings or steps between the stationary crutches (Figure 8–22). The athlete should avoid placing the major support in the axilla.
3. After moving through, the athlete recovers the crutches and again places the tips forward.

An alternate method is the four-point crutch gait. In this method, the athlete stands on both feet. One crutch is moved forward, and the opposite foot is stepped forward. The crutch on the same side as the foot that moved forward moves just ahead of the foot. The opposite foot steps forward, followed by the crutch on the same side, and so on.

Once the athlete is able to move effectively on a level surface, negotiating stairs should be taught. As with level crutch walking, a tripod is maintained on stairs. In going upstairs, the unaffected support leg moves up one step while the body weight is supported by the hands. The full weight of the body is transferred to the support leg, followed by moving the crutch tips and affected leg to the step. In going downstairs, the crutch tips and the affected leg move down one step, followed by the support leg. If a handrail is available, both crutches are held by the outside hand, and a similar pattern is followed as with the crutch on each side. The phrase "up with the good—down with the bad" may help the athlete remember the correct sequence.

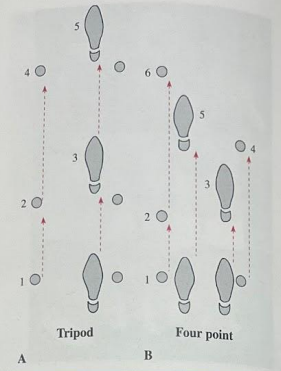


FIGURE 8–22 Crutch gait. **(A)** Tripod method. **(B)** Four-point gait.

When the injured athlete needs to be partially weight bearing, a cane or perhaps a single crutch can be used to help with balance. In this case, the athlete should hold the cane or crutch in the hand on the uninjured side and move the cane forward simultaneously with the injured leg. The athlete should avoid leaning too heavily on the cane or crutch. If this is a problem, then the athlete should use two crutches.

Cerebral Concussion (Brain Injury)

Concussion, a type of **brain injury (BI)**, has become a widely publicized public health concern with increased attention focusing on treatment and management.[9] Despite the increasing occurrence and prevalence of concussions in athletics, there is no universally accepted definition, or standard, for its assessment. Deciding when a patient can safely return to participation following a concussion is perhaps the most challenging task for any sports medicine clinician.

Direct blows occur when the athlete is struck in the head by some object (e.g., a ball, a baseball bat, a lacrosse stick, or contact with another player). direct blow may also occur when the athlete's moving head strikes some fixed object (e.g., the floor, a goalpost), resulting in impact deceleration of the brain. A blow to the head can produce an injury to the brain either at the point of contact (*coup injury*) or on the opposite side, which is referred to as a *contrecoup injury*. An example of a contrecoup mechanism would be a whiplash injury. Acceleration, deceleration, and particularly rotational forces produce shaking of the brain within the skull.[9]

Signs of Injury The most current thinking relative to diagnosing an acute concussion is that assessment should involve a variety of symptoms and signs, including these:[9,22]

- Clinical symptoms
  - Somatic (e.g., headache)
  - Cognitive (e.g., feeling "in a fog")
  - Emotional (e.g., unusually emotional)
- Physical signs (e.g., blurred vision, occcasional loss of consciousness, light sensitivity)
- Behavioral changes (e.g., irritability)
- Cognitive impairment (e.g., slowed reaction times)
- Sleep disturbance (e.g., drowsiness)

If any one or more of these signs or symptoms is present, a concussion should be suspected and the appropriate management strategy instituted.

For many years, the medical community in general, and sports medicine practitioners in particular, attempted to classify concussions into various grades by looking primarily at the physical symptoms, which included the level of consciousness and post-traumatic amnesia. It now seems that there may have been too much emphasis placed on these grading scales.[40] **It appears that the most logical approach is to determine the severity of the concussion based on the presence and overall duration of symptoms only after all concussion signs and symptoms have resolved.**[22] This approach places less emphasis on loss of consciousness and amnesia as potential predictors of subsequent impairment. Instead, attention should be focused on the patient's recovery via duration of symptoms, neurocognitive tests, and postural stability tests (balance), and not by using a grading scale.[22] In this approach, the focus is on whether the patient is symptomatic or asymptomatic. The Graded Symptoms Checklist in Table 8–2 lists the most common signs and symptoms that occur with concussion.

Management of concussions

The immediate care for an athlete who has sustained a concussion or mild traumatic brain injury is clear and leaves no room for doubt. **Any athlete who sustains a concussion must be removed from competition immediately and not allowed to return to physical activity until cleared by a physician.**[17] In fact, since 2009, all 50 states and the District of

TABLE 8–2 GRADED SYMPTOM CHECKLIST

Blurred vision	Memory problems
Dizziness	Nauseous
Drowsiness	Nervousness
Sleeping more than usual	Personality changes
Easily distracted	Poor balance/coordination
Fatigue	Ringing in the ears
Feeling "in a fog"	Sadness
Feeling "slowed down"	Seeing stars
Headache	Sensitivity to light
Unusually emotional	Sensitivity to noise
Irritability	Sleep disturbances
Loss of conciousness	Vacant stares/glassy eyes
Loss of orientation	Vomiting

Focus Box 8–5

When an athlete shows any signs of a concussion: [22]

1. *The athlete should be medically evaluated onsite using standard emergency management principles, and particular attention should be given to excluding a cervical spine injury.*
2. *The appropriate disposition of the athlete must be determined by the treating health care provider in a timely manner. If no health care provider is available, the athlete should be safely removed from practice or play and urgent referral to a physician arranged.*
3. *Once the first aid issues are addressed, then an assessment of the concussive injury should be made.*
4. *The athlete should not be left alone following the injury, and serial monitoring for deterioration is essential over the initial few hours following injury.*
5. *An athlete with diagnosed concussion must not be allowed to return to play on the day of injury.*

Columbia passed laws to address how traumatic brain injury should be managed. The majority of these states enacted legislation directed at youth sports-related concussions. The laws in individual states vary somewhat but, in general, they require development of an athletic concussion safety training program for coaches, school nurses, athletic directors, volunteers, student athletes, and their parents. The laws require that any athlete who exhibits signs of concussion be immediately removed from the activity and not permitted to practice that day or any subsequent day until he or she is evaluated by, and receives written clearance for such participation from, a qualified health care professional.[33] *Schools are also required to develop emergency action plans and maintain records of any concussive events.*[34]

Any time an athlete loses consciousness for any reason, he or she must be removed from further activity immediately.[14] *If he or she has sustained a concussion that causes unconsciousness, a cervical spine injury must also always be suspected. In this case, the rescue squad should be called and must remove the athlete from the field, using a spine board.*[35]

Focus Box 8–5 details the procedures that should be followed on the sidelines with an athlete who has sustained a concussion. It is certainly possible that the athlete's condition may deteriorate, either immediately (within minutes to hours) or over several days after the injury. Thus physician follow-up are essential in managing a concussion.[36]

The decision about when to allow an athlete with a concussion to return to play is not so clear cut. The recovery period following even a mild head injury may be longer than has been thought in the past, requiring at least 3 to 5 days to be symptom free. Athletes who have sustained a concussion should not be permitted to return to any type of physical activity until it is either self-reported or directly observed that all postconcussive symptoms have resolved.[42] *Once the athlete is free of postconcussive symptoms, he or she should not be placed back into practice or competition immediately. Instead, the athlete should be gradually progressed through physical activities that have specific criteria for progression.* **Again, the athlete may not return to play unless a physican clears him or her to return.**[22]

Even after postconcussive symptoms have disappeared and the athlete has returned to play, it has been demonstrated that with repeated concussions the severity and duration of functional impairment may be greater and that these changes may be cumulative. Once a patient has sustained an initial cerebral concussion, his or her chances of incurring a second one are three to six times greater than for a patient who has never sustained concussion.[9] *Therefore, if a patient sustains more than one concussion, the team physician must decide whether to allow the patient to continue to compete.*

8–4 Critical Thinking Exercise

A high-school lacrosse player experienced a concussion with a brief loss of consciousness. One week later, the patient is symptom free except for a headache.

Should the athletic trainer allow the patient to resume normal contact activity at this point?

In cases of multiple repetitive concussion or mild traumatic brain injury, it is possible that over the long term of many years, an athlete could develop chronic traumatic encephalopathy (CTE), a progressive degenerative disease that can ultimately cause dementia, depression, confusion, memory loss, or aggression.[23] *Permitting an athlete, particularly one in a contact sport, to return before postconcussive symptoms resolve may place that athlete at risk of postconcussion syndrome or second-impact syndrome.*

Recognizing and Managing Less Common Medical Conditions in Athletes

Sudden Cardiac Death Syndrome (SCD)

It is **catastrophic** *when a young individual dies suddenly for no apparent reason. In individuals 35 years and younger, the most common cause of exercise-induced sudden cardiac death is a congenital cardiovascular abnormality. The three most prevalent conditions are hypertrophic cardiomyopathy, anomalous origin of the coronary artery, and Marfan's syndrome. Other potential causes of sudden cardiac death include coronary artery disease (CAD) and peripheral artery disease (PAD). All of these conditions have the potential to result in a* **myocardial infarction(MI)** *or heart attack which causes injury to the cardiac muscle because of a lack of oxygen due to interference with the blood supply.*[13]

Sudden death also has several noncardiac causes, including the use of certain drugs, such as alcohol, cocaine, amphetamines. A vascular event—bleeding in the brain caused by a cerebral **aneurism**, *or head trauma that causes intracranial bleeding—may also result in sudden death.*[5]

Most afflicted patients have no symptoms before death. Common symptoms and signs associated with sudden cardiac death include chest pain or discomfort during exertion, heart flutters, syncope, nausea, profuse sweating, heart murmurs, shortness of breath, general malaise, and fever.[10]

It has been suggested that a major number of deaths could be avoided by counseling, screening, and early identification of preventable causes of sudden death. It currently appears that a history and physical exam are the most effective methods of preparticipation screening.[13,12] *Initial screening should include the following questions:*

- *Has a physician ever told you that you have a heart murmur?*
- *Have you had chest pain during exercise?*
- *Have you fainted during exercise?*
- *Has anyone in your family under age 35 died suddenly?*
- *Has anyone in your family been diagnosed with a thickened heart?*
- *Does anyone in your family have Marfan's syndrome?*

If the answer to any of these questions is yes the athlete should be referred to a cardiologist for further evaluation.

Stroke

A **stroke** *is a medical emergency that occurs when the brain is deprived of oxygen and nutrients because of some interruption of the blood supply to part of the brain. In a stroke, brain cells begin to die within a matter of minutes.*[41]

There are two types of strokes. The most common is an ischemic stroke which occurs when the arteries in the brain become narrowed and are blocked by either a **thrombus** *(a blood clot which forms in the brain) or an* **embolism** *(a blood clot that forms somewhere else like in the heart or legs and migrates to the brain). The second less common type is a hemorrhagic stroke which occurs from an* **aneurism** *(an area of weakness in a blood vessel) which either leaks blood or completely ruptures disrupting oxygenated blood flow to a part of the brain.*[28]

Risk factors that can predispose or precipitate a stroke may include: being overweight, physical inactivity, high cholesterol, hypertension, diabetes, personal or family history, drug abuse, binge drinking, cigarette smoking, sleep apnea, and being male, age 55 or older.

It is critical that the signs and symptoms of a stroke are recognized quickly. Prompt and correct treatment can minimize brain damage and thus potentially life-altering complications. The most common signs and symptoms include:

- *slurring of words with difficulty understanding speech*