Basic Athletic Training
Course Pack A

CHAPTER

7

Acute Injuries: Assessment and Disposition

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STUDENT OUTCOMES

1. Identify planning strategies designed to prevent the incidence and severity of acute injury and enhance an effective and appropriate response.
2. Design a venue-specific emergency action protocol.
3. Define triage and explain the importance of triage when assessing acute injuries.
4. Delineate between a primary and secondary survey.
5. List the primary questions asked during the history portion of an on-field assessment of a patient with an acute injury.
6. Describe the components of an on-site inspection and

palpation.

7. Compare how muscle and joint function is assessed on field as compared to how muscle and joint function is assessed in nonacute, off-field situations.
8. Explain how to conduct an on-field neurological examination.
9. List the components of a vital sign assessment and identify normal findings.
10. Identify the signs and symptoms of acute fracture and management strategies.
11. Describe proper procedures for removal of protective equipment.
12. Explain different procedures for transporting the patient from the site of injury.
13. Identify patients who are experiencing conditions that may result in sudden death in sports, and explain the appropriate acute response.

INTRODUCTION

No other act in athletic training gets the heart racing as much as being called out to the scene of an acute injury where there is the potential of finding a patient in a life-threatening situation. Upon arriving at the scene, the athletic trainer needs to assess the situation, evaluate the patient, determine the type and extent of injury that has been sustained, and provide immediate appropriate care. In an acute injury situation, the presence of life-threatening conditions should be established or ruled out, followed by conditions that may develop into life-threatening conditions if not properly addressed in a timely manner. Next, orthopedic injuries should be addressed in order of severity: fractures, dislocations, grade 3 strains and sprains, significant open wounds, etc. Within this chapter, strategies for preventing and preparing for emergency situations and minimizing the extent of injury are presented. Assessment methods for

evaluating patients with acute injury are then discussed followed by strategies to remove patients from the injury site. Finally, this chapter provides a review of the leading causes of sudden death in sports along with the recognition and acute management of these conditions.

THE EMERGENCY ACTION PLAN

? A gymnast slipped off the springboard on an approach to a vault and collided full force into the horse. As the on-site athletic trainer, you observe the gymnast lying motionless on the floor. Based on this information, is it appropriate to activate the institution's emergency medical plan?

Administrators, medical directors, athletic trainers, and coaches all have shared responsibilities to ensure that the athlete's short- and long-term health is protected.[1] The majority of the responsibility falls on the supervising physician and athletic trainer; however, each person has differing levels of responsibility in meeting this goal. The Inter-Association Consensus Statement on Best Practices for Sports Medicine Management for Secondary Schools and Colleges recommends using a concept referred to as athlete-centered medicine when designing policies and procedures for the prevention of injury and provision of health care.[1] The recommendations put forth in the consensus statement are presented in **Box 7.1**. A primary consideration is the inclusion of a well-written emergency action plan.

BOX 7.1 Best Practices in Planning to Prevent or Decrease the Incidence and Severity of Acute Injury

- Establish and define the relationships among all involved parties.
- Develop a chain of command regarding provision of health care and medical decision making, with the supervising physician as the final authority.

- Establish a safe practice and playing environment by monitoring environmental risk factors.
- Develop and implement an EAP.
- Plan and train for emergencies during competition and practice sessions.
- Determine which venues and activity settings require the on-site presence of the athletic trainer and team physician and which sites require that they be available.
- Provide appropriate health care during events, and ensure an adequate number of athletic trainers for the number of sport participants.
- Establish criteria for safe return-to-practice and play and implement the return-to-play (RTP) process.

Adapted from Courson R, Goldenberg M, Adams KG, et al. Inter-association consensus statement on best practices for sports medicine management for secondary schools and colleges. *J Athl Train*. 2014;49(1):128–137.

Although the rate of catastrophic injury in sports is low, the more prepared and better practiced the athletic trainer and sports medicine team is in responding, the more successful the response will be.[2] The **emergency action plan** (EAP) serves as a blue print on how to respond to emergency situations. The EAP should be a written document that is comprehensive yet flexible enough to adapt to any emergency situation at any activity venue. The plan should identify the following general principles[3]:

- The personnel, with their qualifications, needed to perform responsibilities in executing the plan
- Equipment needed to carry out the tasks required in the event of an emergency
- The mechanism of communication to the emergency care providers and the mode of transportation for the patient
- The facilities to which the patient will be taken, including how and when

those facilities will be notified in advance of the scheduled event or contest

- Documentation verifying the implementation and evaluation of the emergency plan, actions taken during the emergency, evaluation of the emergency response, and institutional personnel training
- Documentation of an annual review and rehearsal of the emergency plan and notations indicating whether the emergency plan was modified and, if so, how the plan was changed

Every institution/facility should have an emergency response team. The team should be composed of athletic training personnel, personnel responsible for the overall health and safety of students (e.g., campus police/safety), and the campus medical director. The designated emergency response team should meet with representatives from local **emergency medical service** (EMS) agencies and emergency departments to discuss, develop, and evaluate the facility's emergency plan. As part of this process, individual responsibilities and protocols for an emergency situation should be determined. In developing the emergency medical plan, it is important to recognize that in any given situation, the members of the emergency response team can vary. For example, a physician may or may not be on site, the athletic trainer may be working alone or part of an on-site staff, and emergency medical technicians may be present at an event or available only if summoned. The following questions should be addressed relative to each event:

- What emergency equipment must be available on site?
- What equipment will be provided by the local EMS agency (e.g., spine board and splints) if in attendance at an event?
- Who will be responsible for ensuring that the emergency equipment is operational?
- What type of communication will be used to contact emergency personnel? Who will activate the facility's emergency medical plan?
- Who will assess the injured individual on site, and under what circumstances will a local EMS agency be called to the site?

- If a physician is present, what are the responsibilities of other medical personnel (e.g., athletic trainer and emergency medical technician)?
- If a physician is not present and the athletic trainer is evaluating the situation, what are the responsibilities of emergency medical technicians responding to the situation?
- If it becomes necessary to stabilize and transport an individual to a medical facility, who will direct the stabilization and what protocol will be followed for the removal of protective equipment?
- Who will supervise other participants if the athletic trainer is assessing and providing care to an injured individual?
- Who will be responsible for the proper disposal of items and equipment exposed to blood or other bodily fluids?

A written emergency protocol should be developed for each activity site to address these questions (Box 7.2). The emergency response team should practice the emergency plan through regular educational workshops and training exercises. The use of interactive or simulation practice exercises can better prepare individuals to assume their roles in rendering emergency care.

BOX 7.2 Sample Venue-Specific Emergency Protocol

Springfield University Emergency Protocol for Potter Field

1. **Call 555 to notify campus security** to activate **EMS**.
   - **Instruct** personnel to "report to and meet at, as we have an injured student-athlete in need of emergency medical treatment."
   - **Location:** Springfield University Potter Field
   - **Directions:** Street entrance (gate off of Wilbraham Avenue). Cross street: Alden Street.
2. **Provide necessary information to dispatch officer:**
   - Name, address, telephone number of caller

- Number of victims; condition of victims
- First aid treatment initiated
- Specific location of patient as needed to locate scene
- Other information as requested by dispatcher

3. **Provide appropriate emergency care** until arrival of EMS personnel.
4. **On arrival of EMS personnel:**
   - Provide pertinent information (method of injury, vital signs, treatment rendered, medical history).
   - Assist with emergency care as needed.
5. **Note:** Athlete should be accompanied by member of coaching staff, residence life staff, or other university representative.
   - Athletic training staff cannot leave the venue without another health care provider present in order to accompany the athlete to the emergency department. A staff member should accompany the student-athlete to hospital.
   - Notify the director of athletic training health care services of any action taken.
   - Complete and enter information in patient's medical chart upon return to the main athletic training facility.
6. **Emergency hand signals**
   - **Activate EMS:** Make large circular motion overhead.
   - **Need AED/O_2 emergency jump kit:** Tap self on chest several times with overexaggerated motions.
   - **Need splint kit:** Tap self twice with open hand on either arm or leg to indicate location of fracture dislocation.
   - **Need stretcher:** supinated hands in front of body or waist level

Adapted from Andersen JC, Courson RW, Kleiner DM, et al. National Athletic Trainers' Association position statement: emergency planning in athletics. *J Athl Train*. 2002;37(1):99–104.

Although the condition of the gymnast may eventually warrant activation of the institution's emergency medical plan, there is not sufficient information at this point to activate the plan. The athlete may be unconscious or may be self-assessing his level of pain prior to moving. It is important that the athletic trainer assess the athlete's condition to determine whether activation of the emergency medical plan is necessary.

ASSESSING EMERGENT CONDITIONS

In assessing the condition of the injured gymnast, what sequential process can be used to determine if the central nervous system (CNS) and/or cardiorespiratory systems are critically injured? What conditions warrant activation of the emergency medical plan, including summoning the local EMS agency?

Injuries or conditions that impair, or that have the potential to impair, vital function of the CNS and cardiorespiratory system are considered to be emergency situations. In responding to an on-field or on-site injury, the initial assessment performed by the athletic trainer is intended to rule out any life-threatening conditions. The **primary survey** determines the level of responsiveness and assesses the airway, breathing, and circulation. If at any time during the assessment conditions exist that are an immediate threat to life, or if "red flags" are noted (Box 7.3), the assessment process should be terminated and the emergency medical plan should be activated.

BOX 7.3 Red Flags Indicating a Serious Emergency Resulting in Activation of the Emergency Medical Plan

- Unconscious
- Loss of consciousness in the presence of head trauma
- Respiratory distress, failure, or airway obstruction

- No pulse
- ***Severe*** chest or abdominal pains
- Excessive arterial bleeding
- Severe heat illness (core rectal temperature greater than 102°F)
- Severe shock
- Suspected spinal injury
- Fractures involving several ribs, the femur, or pelvis
- Severe hypoglycemia
- Collapse in response to sickling episode (sickling collapse)
- Extreme ranges deviating from normal blood pressure, pulse, or respiration rates

Occasionally, situations can occur in which more than one individual is injured. **Triage** refers to the rapid assessment of all injured patients followed by a return to the most seriously injured to provide immediate treatment.

Once it has been determined that a life-threatening condition does not exist, a secondary survey is performed to identify the type and extent of any injury and the immediate **disposition** of the condition. Decisions must be made regarding the on-field management of the injury (e.g., controlling bleeding or immobilizing a possible fracture or dislocation), the safest method of transportation from the field (e.g., manual conveyance, stretcher, or spine board), and the need for rapid referral of the individual for further medical care.

On-Site History

Regardless of the setting (e.g., on-site or athletic training clinic), assessment protocols should contain the same basic components. During an on-field (on-site) assessment, the athletic trainer should assume a position close to the injured individual. One hand should be placed on the forehead of the injured individual to stabilize the head and neck to prevent any unnecessary movement.

The history of the injury can be obtained from the individual or, if the individual is unconscious, from bystanders who may have witnessed the injury. Questions should be open-ended to allow the person to provide as much information as possible about the injury. The athletic trainer should listen attentively for clues that may indicate the nature of the injury. On-site history taking should be relatively brief as compared to a more comprehensive clinical evaluation. Critical areas of information include the following:

- **The location and type of pain.** The site of the injury should be identified; it is important to be aware that several areas may be injured. Sharp intense pain may be associated with a fracture, whereas throbbing pain may indicate ligamentous injury.
- **The presence of abnormal neurological signs.** The presence of any tingling, numbness, or loss of sensation should be noted, and nerve involvement should be suspected.
- **The mechanism of injury.** The position of the injured body part at the point of impact and the direction of force should be identified.
- **Associated sounds.** A report of hearing a "snap" or a "pop" may indicate a fracture or rupture of a ligament or tendon.
- **A history of the injury.** A preexisting condition or injury may have exacerbated the current injury or may complicate the injury assessment. Depending on the urgency of the situation and the severity of the current injury, a history that involves seeking information about past injury to same area may or may not be needed.

The history part of the evaluation will enable the athletic trainer to determine the possibility of an associated head or spinal injury, to rule out injury to other body areas, and, if necessary, to calm the individual. If the individual cannot open his or her eyes on verbal command or does not demonstrate withdrawal from painful stimulus, a serious red flag injury exists. Application Strategy 7.1 lists several questions used to determine a history of the injury and to assess the level of responsiveness.

APPLICATION STRATEGY 7.1

Determining the History of Injury and Level of Responsiveness

Stabilize the head and neck. Do not move the individual unnecessarily until a spinal injury is ruled out. If nonresponsive,

1. Call the person's name loudly and gently tap the sternum or touch the arm. If there is no response, rap the sternum more forcibly with a knuckle or pinch the soft tissue in the armpit (axillary fold). Note if a withdrawal from the painful stimulus occurs. If no response, immediately initiate EMS and begin the primary survey.
2. If ABC are adequate, gather a history of the injury. If you did not see what happened, question other players, supervisors, officials, and bystanders. Ask:
   - What happened?
   - Did you see the individual get hit, or did the individual just collapse?
   - How long has the individual been unresponsive?
   - Did the individual become unresponsive suddenly or deteriorate gradually?
   - If it was gradual, did anyone talk to the individual before you arrived?
   - What did the person say? Was it coherent? Did the person moan, groan, or mumble?
   - Has this ever happened before to this individual?

If conscious, ask:

1. What happened? Note if the individual is alert and aware of his or her surroundings or has any short- or long-term memory loss. If the individual is lying down, determine if the person was knocked down, fell, or rolled voluntarily into that position.
2. Are you in pain? Where is the pain? Is it localized, or does it radiate

into other areas?

3. Did you hear any sounds or any unusual sensations when the injury occurred?
4. Have you ever injured this body part before or experienced a similar injury?
5. Do you have a headache? Are you experiencing any nausea? Are you dizzy? Can you see clearly?
6. Are you taking any medication (e.g., prescription, over the counter, or vitamins)?

It is important to avoid leading the individual. Instead, the individual should be encouraged to describe what happened, and the clinician should listen attentively for clues to the nature of the injury.

On-Site Observation and Inspection

In an on-site evaluation, observation begins while watching the athlete participating. An alert athletic trainer may witness how the forces were applied, which body part sustained contact, and the athlete's immediate response to the blow. For example, an athlete slides head first into the boards during a hockey game and remains motionless on the ice. From this scenario, the clinician immediately suspects a cervical spinal cord injury even before taking a history or arriving at the side of the injured athlete. When the mechanism of injury has not been witnessed, the initial observation is often conducted as you approach the injured individual and, therefore, occurs prior to the history taking. Critical areas to observe include the following:

- **The surrounding environment.** Note any equipment or apparatus that may have contributed to the injury.
- **How the patient responded to the blow.** Was there immediate deformity or dysfunction apparent? Notice if the patient attempted to utilize the body part but was unsuccessful. Athletes who fall to the ground without placing arms out to break the fall may already be unconscious or have neurological

impairment.

- **Body position.** The position of the individual (e.g., prone, supine, or side lying) should be observed. The appearance of a gross deformity in one of the limbs should be noted. In severe brain injuries, a neurological sign called "posturing" of the extremities can occur (Fig. 7.1). **Decerebrate rigidity** is characterized by an extension of all four extremities. **Decorticate rigidity** is characterized by an extension of the legs and marked flexion in the elbows, wrists, and fingers.

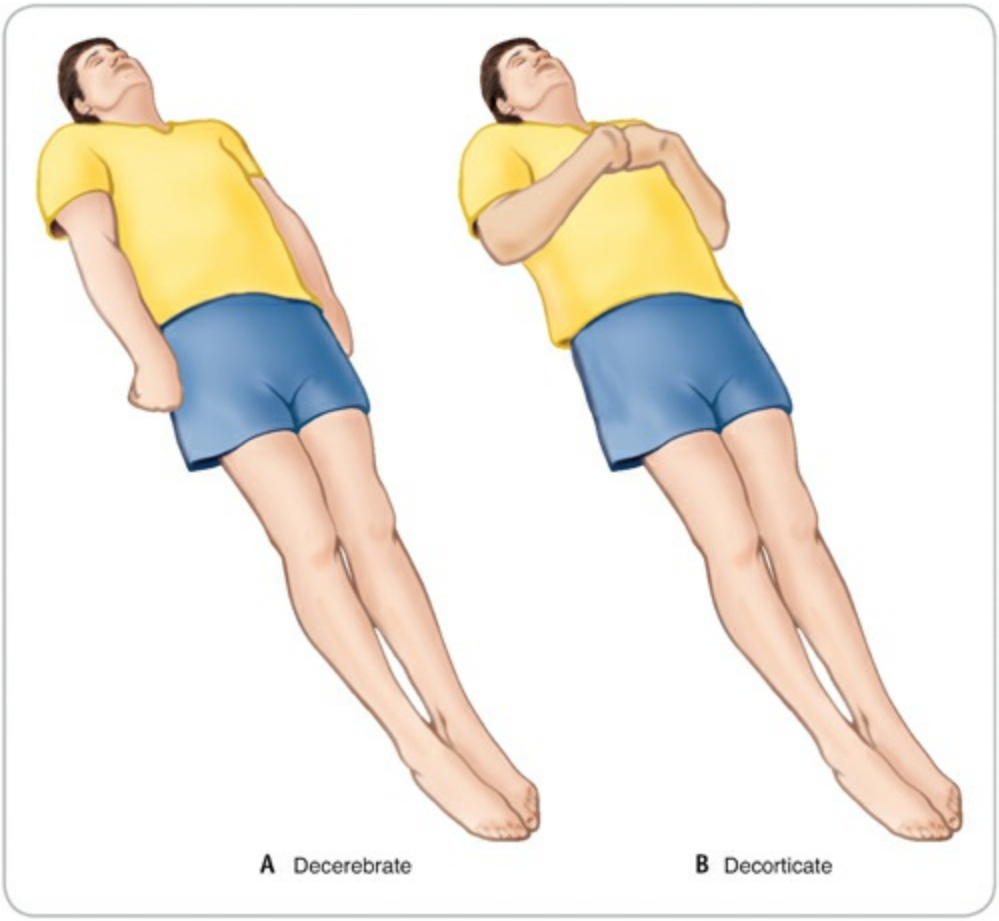

Figure 7.1. **Body posturing. A,** Decerebrate rigidity is characterized by extension in all four extremities. **B,** Decorticate rigidity is characterized by the extension of the legs and flexion of the elbows, wrist, and fingers. Both conditions indicate a severe brain injury.

- **Movement of the individual.** An individual holding an injured body part and expressing pain indicates consciousness as well as an intact CNS and cardiovascular system. If the individual is not moving or is having a seizure, possible systemic, psychological, or neurological dysfunction

should be suspected.

- **The level of responsiveness.** Sometimes referred to the "shake and shout" stage, the clinician tries to arouse the unconscious individual by touching or gently tapping (without moving the head or neck) and by shouting into each ear. This action will determine whether the person is alert, restless, lethargic, or nonresponsive. There are several different ways to assess and document level of responsiveness. From a basic first aid perspective, the mnemonic AVPU (alert, voice, pain, unresponsive) is used.[4] EMSs utilize A/OX4, whereas emergency departments and neurological may depend on the Glasgow Coma Scale.[5] Comparisons of these scales are presented in Table 7.1.

TABLE 7.1 Scales for Assessing Level of Responsiveness

NAME	PURPOSE OF SCALE	CRITERIA/SCORING			
AVPU	Simple and quick way to measure patient's responsiveness, thus indicating level of consciousness; based on four criteria	**Alert (A):** fully awake and spontaneously engages **Voice (V):** appears "out of it" and needs verbal prompts to respond; may grunt, moan, or slightly move limb in response to questions **Pain (P):** does not respond to voice but will respond to painful stimulus **Unresponsive (U):** no eye, voice, or motor response to painful stimulus			
A/OX4	Alert and oriented in four areas: name, location, time, and event. For each area correctly identified, 1 point is awarded.	1. Does the patient know his or her name? 2. Does the patient know where he or she is? 3. Does the patient know the time? 4. Does the patient know what happened or what is happening?			
Glasgow Coma Scale (GCS)[5]	Assesses function in three spheres and awards points based on response; can be used to obtain baseline information for comparison with future tests. Points are awarded based on response.	**Eye Opening** 4 = spontaneously 3 = to voice stimulus 2 = to painful stimulus 1 = do not open 1 = no response	**Verbal Response** 5 = normal conversation 4 = disoriented conversation 3 = words, not coherent 2 = no words, just sound 2 = decerebrate posture	**Motor Response** 6 = normal response 5 = localizes to pain 4 = withdrawals to pain 3 = decorticate posture 1 = no response	
Comparison of AVPU and GCS[6]		A = GCS 15	V = GCS 12	P = GCS 8	U = GCS 3

- **The primary survey.** The "ABC technique" should be employed to ensure an open *A*irway, adequate *B*reathing, and *C*irculation.
- **Inspection for head trauma.** The pupils of the eyes should be observed, noting a normal appearance, dilation, or constriction. The presence of unequal pupils (**anisocoria**) (Fig. 7.2) may indicate the presence of bleeding within the brain. The facial area and the area behind the ears should be inspected for any redness or ecchymosis. Ecchymosis under the eye (**raccoon eyes**) or behind the ear (**Battle sign**) suggests the presence of a fracture of the bones of the face and skull (Fig. 7.3). The presence of any clear fluid or bloody discharge from the ears or nose should be noted; this

fluid could be cerebrospinal fluid leaking from the cranial area as a result of a skull fracture.

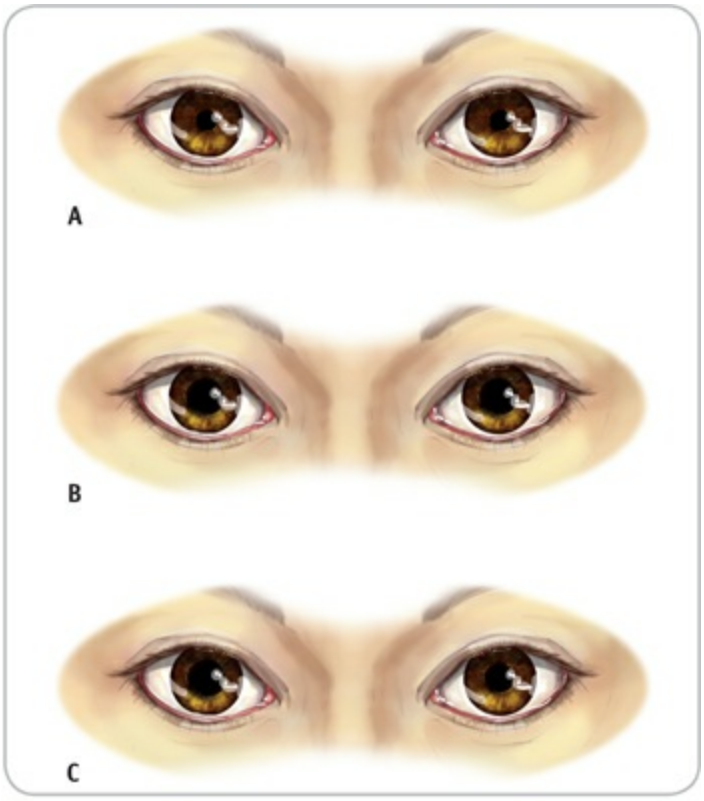

Figure 7.2. Assessing pupil size and reaction. A, Pinpoint is commonly observed in poisonings, brainstem dysfunction, and opiate use. **B,** Dilated but reactive is seen in the dark or occasionally after seizures. Fixed and dilated is associated with brainstem herniation secondary to increased cranial pressure (ICP) (e.g., severe cranial injury). **C,** One dilated and fixed may indicate ipsilateral uncal herniation with oculomotor (cranial nerve III) compression or a subdural or epidural hematoma. Note that anisocoria (unequal pupil size) is a normal variant.

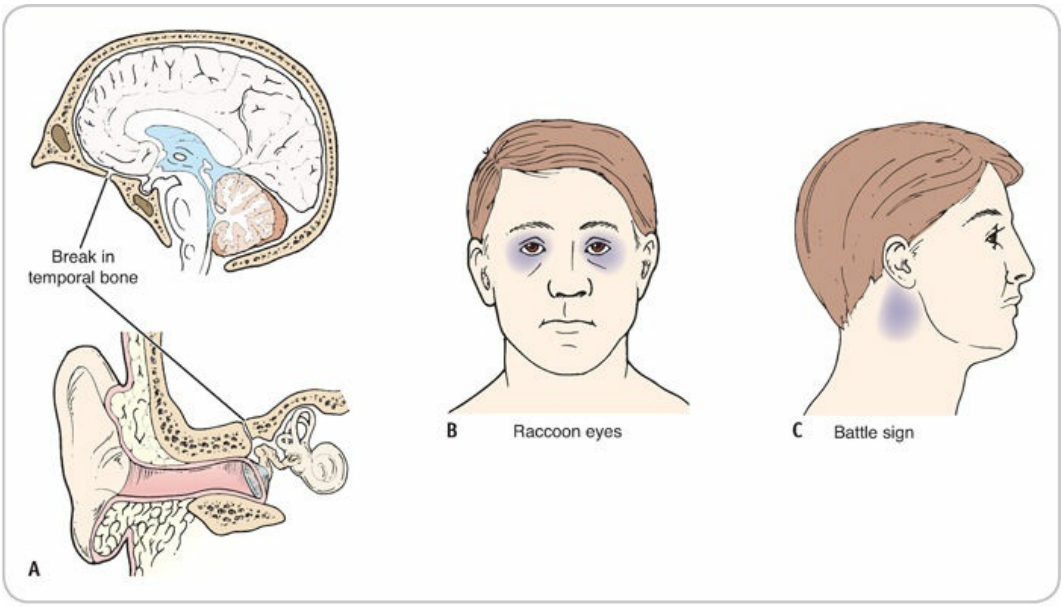

Figure 7.3. **A,** Basilar skull fractures in the temporal bone can cause cerebrospinal fluid (CSF) to leak from the nose or ear. **B,** Periorbital ecchymosis, called raccoon's eyes, may result from a facial fracture or basilar skull fracture. **C,** Battle sign over the mastoid process is also a sign of basilar fracture but may not become apparent until several days following the injury. There may be bloody drainage from the ear immediately following the fracture.

- **Inspection of the injured body part.** The injured area should be checked for joint alignment, redness, ecchymosis, swelling, or cuts. These observations should always be compared to the uninjured body part.

On-Site Palpation

The palpation should include a general head-to-toe assessment. This is done using a gentle, squeezing motion to palpate methodically down the trunk of the body to the fingers and toes. Palpation includes the following:

- **Bony palpation**
- **Possible fractures**—detected with palpation, percussion, vibration, compression, and distraction (see Fig. 6.2)
- **Crepitus**—associated with fracture, swelling, or inflammation
- **Soft-tissue palpation**
- **Swelling**—may indicate diffuse hemorrhage or inflammation in a muscle, ligament, bursa, or joint capsule
- **Deformity**—an indentation may indicate a rupture in a musculotendinous

unit; a protruding, firm bulge may indicate a joint dislocation, ruptured bursa, muscle spasm, or hematoma.

- **Skin temperature**
- Normally, the skin is dry, but certain conditions, such as cold, shock, or fever, can alter surface blood vessels.
- Skin temperature is assessed by placing the back of the hand against the individual's forehead or by palpating appendages bilaterally.

On-Site Functional Testing

When not contraindicated, the athletic trainer should identify the individual's willingness to move the injured body part. For a lower extremity injury, this should be expanded to include the willingness to bear weight. Movement is contraindicated, however, in the presence of a possible head or spinal injury, fracture, dislocation, or muscle/tendon rupture. Functional testing includes the following:

- **Active range of motion (ROM).** The individual is asked to move the injured body part through the available ROM. The quantity and quality of movement in the absence of pain should be noted.
- **Weight bearing.** If the individual successfully completes active, passive, and resisted motion ROMs, walking may be permitted. If the individual is unable to perform these tests, however, or if critical signs and symptoms are apparent, removal from the area should be performed in a non–weight-bearing manner.

On-Site Stress Testing

Testing for ligamentous integrity is performed before any muscle guarding or swelling occurs that may obscure the extent of injury. Typically, only single-plane tests are performed, the results of which are then compared with the noninjured limb.

On-Site Neurological Testing

Neurological testing is critical to prevent a catastrophic injury. Although listed as a separate testing phase, neurological testing, if warranted, may be performed earlier in the evaluation. Critical areas to include are as follows:

- **Cutaneous sensation.** This can be done by running the fingernails along both sides of the injured individual's arms and legs to determine if the same feeling is experienced on both sides of the body part. Pain perception also can be tested by applying a sharp and a dull point to the skin; the ability of the individual to distinguish the difference should be noted.
- **Motor function.** A cranial nerve assessment (see Chapter 20) should be completed. In addition, the ability of the individual to wiggle the fingers and toes on both the hands and the feet should be assessed, and a bilateral comparison of grip strength should be performed.
- **Reflexes.** Damage to the CNS can be detected by stimulation of the deep tendon reflexes (DTRs). Exaggerated, distorted, or absent reflexes indicate injury in specific regions of the nervous system. However, DTRs are not normally assessed during evaluation of acute, on-field injuries. Pathologic reflexes (see **Table 6.14**) can indicate upper motor neuron lesions if bilateral or lower motor neuron lesions if unilateral. The presence of the reflex often serves as a sign of some pathologic condition.

Vital Signs

When warranted, the vital signs should be assessed to establish a baseline of information. Vital signs indicate the status of the cardiovascular system and the CNS and include pulse, respiratory rate and quality, blood pressure, and temperature. Although not specifically cited as vital signs, skin color, pupillary response to light, and eye movement also may be assessed to determine neurological function. Abnormal vital signs indicate a serious injury or illness (**Table 7.2**).

TABLE 7.2 Abnormal Vital Signs and Possible Causes	
PULSE	
Rapid, weak	Shock, internal hemorrhage, hypoglycemia, heat exhaustion, or hyperventilation
Rapid, bounding	Heat stroke, fright, fever, hypertension, apprehension, hyperglycemia, or normal exertion
Slow, bounding	Skull fracture, stroke, drug use (barbiturates and narcotics), certain cardiac problems, or some poisons
No pulse	Blocked artery, low blood pressure, or cardiac arrest
RESPIRATORY RATE AND QUALITY	
Shallow breathing	Shock, heat exhaustion, insulin shock, chest injury, or cardiac problems
Irregular breathing	Airway obstruction, chest injury, diabetic coma, asthma, or cardiac problems
Rapid, deep	Diabetic coma, hyperventilation, or some lung diseases
Frothy blood	Lung damage, such as a puncture wound to the lung from a fractured rib or other penetrating object
Slowed breathing	Stroke, head injury, chest injury, or use of certain drugs
Wheezing	Asthma
Crowing	Spasms of the larynx
Apnea	Hypoxia (lack of oxygen), congestive heart failure, or head injuries
No breathing	Cardiac arrest, poisoning, drug abuse, drowning, head injury, or intrathoracic injuries, with death imminent if action is not taken to correct condition
BLOOD PRESSURE	
Systolic <100 mm Hg	Hypotension caused by shock, hemorrhage, heart attack, internal injury, or poor nutrition
Systolic >140 mm Hg	Hypertension caused by certain medications, oral contraceptives, anabolic steroids, amphetamines, chronic alcohol use, and obesity
SKIN TEMPERATURE	
Dry, cool	Exposure to cold or cervical, thoracic, or lumbar spine injuries
Cool, clammy	Shock, internal hemorrhage, trauma, anxiety, or heat exhaustion
Hot, dry	Disease, infection, high fever, heat stroke, or overexposure to environmental heat
Hot, moist	High fever
Isolated hot spot	Localized infection
Cold appendage	Circulatory problem
"Goose pimples"	Chills, communicable disease, exposure to cold, pain, or fear
SKIN COLOR	
Red	Embarrassment, fever, hypertension, heat stroke, carbon monoxide poisoning, diabetic coma, alcohol abuse, infectious disease, inflammation, or allergy
White or ashen	Emotional stress (e.g., fright or anger), anemia, shock, heart attack, hypotension, heat exhaustion, insulin shock, or insufficient circulation
Blue or cyanotic	Heart failure, some severe respiratory disorders, and some poisoning; in dark-skinned individuals, a bluish cast can be seen in the mucous membranes (mouth, tongue, and inner eyelids), lips, and nail beds
Yellow	Liver disease or jaundice

TABLE 7.2 Abnormal Vital Signs and Possible Causes *(continued)*	
PUPILS	
Constricted	Individual is using an opiate-based drug or has ingested a poison.
Unequal	Head injury or stroke
Dilated	Shock, hemorrhage, heat stroke, use of a stimulant drug, coma, cardiac arrest, or death

Pulse

Factors such as age, gender, aerobic physical condition, degree of physical exertion, medications or chemical substances being taken, blood loss, and stress can influence pulse rate and volume. Pulse usually is taken at the carotid artery because a pulse at that site is not normally obstructed by clothing, equipment, or strappings. Normal adult resting rates range from 60 to 100 beats per minute; for children, the normal resting range is from 120 to 140 beats per minute. Aerobically conditioned athletes may have a pulse rate as low as 40 beats per minute. The pulse rate is assessed by counting the carotid pulse rate for a 30-second period and then doubling it. An assessment of pulse volume, which reflects the sensation of the contraction (e.g., strong/weak), also is important.

Respiration

An individual's breathing rate also varies with gender and age. It averages from 10 to 25 breaths per minute in an adult and from 20 to 25 breaths per minute in a child. The breathing rate is assessed by counting the number of respirations in a 30-second period and then doubling it. The character of the respiration (e.g., rapid, shallow, deep, gasping, or labored) should be noted as well. In addition to assessing the rate of respirations, it may be useful to measure the quality and effectiveness of the patient's respirations. As a person inhales, oxygen is pulled into the lungs to oxygenate the blood. **Blood oxygen levels** or oxygen saturation (SpO_2) is a measurement of the amount of oxygen in the blood. SpO_2 levels are measured using a pulse oximeter (**Fig. 7.4**). The pulse oximeter is placed on the finger and measures the saturation peripherally; the measurement is referred to as the SpO_2 level. Normal SpO_2 levels are between 95 and 100. SpO_2 levels between 95 and 90 are considered low, and the patient would benefit from having oxygen administered.[7] Readings less than 90 is considered hypoxemia, and oxygen should be administered. Levels below 80 may impair brain and heart function; therefore, EMS should be activated and oxygen administered immediately.

Figure 7.4. Pulse oximeter.

Blood Pressure

Blood pressure is the pressure or tension of the blood within the systemic arteries, generally considered to be the aorta. As one of the most important vital signs, blood pressure reflects the effectiveness of the circulatory system. Changes in blood pressure are very significant. **Systolic blood pressure** is measured when the left ventricle contracts and expels blood into the aorta. It is approximately 120 mm Hg for a healthy adult and 125 to 140 mm Hg for healthy children aged 10 to 18 years. **Diastolic blood pressure** is the residual pressure in the aorta between heartbeats and averages 70 to 80 mm Hg in healthy adults and 80 to 90 mm Hg in healthy children aged 10 to 18 years. Blood pressure may be affected by gender, weight, race, lifestyle, and diet. Blood pressure is measured in the brachial artery with a sphygmomanometer and a stethoscope (see Application Strategy 2.1).

Temperature

Core temperature can be measured by a thermometer placed under the tongue, in the ear, or armpit or rectum. Average oral temperature usually is quoted at 37°C (98.6°F), but this can fluctuate considerably. During the early morning hours, it may fall as low as 35.8°C (96.4°F), and during the later afternoon or evening hours, it may rise as high as 37.3°C (99.1°F). Rectal temperatures are

higher than oral temperatures by an average of 0.4° to 0.5°C (0.7° to 0.9°F). This is important to remember when assessing a patient with heat illness. Using oral temperature to assess for heat illness may provide inadequate information to determine appropriate treatment.[8] In contrast, axillary temperatures are lower than oral temperatures by approximately 1°F.[9]

Skin Color

Skin color can indicate abnormal blood flow and a low blood oxygen concentration in a particular body part or area. Three colors commonly are used to describe light-skinned individuals: red, white or ashen, and blue. The colors and their potential indications also can be seen in **Table 7.2**. In dark-skinned individuals, skin pigments mask cyanosis; however, a bluish cast can be seen in mucous membranes (e.g., mouth, tongue, and inner eyelids), the lips, and nail beds. Fever in these individuals can be seen by a red flush at the tips of the ears.

Pupils

The pupils are extremely responsive to situations affecting the CNS. The mnemonic PEARL (pupils equal and reactive to light) is used to identify pupil assessment (**Table 7.3**). The rapid constriction of pupils when the eyes are exposed to intense light is called the **pupillary light reflex**. The pupillary response to light can be assessed by holding a hand over one eye and then moving the hand away quickly, or by shining light from a penlight into one eye and then observing the pupil's reaction. A normal response would be constriction with the light shining in the eye and dilation as the light is removed. The pupillary reaction is classified as brisk (normal), sluggish, nonreactive, or fixed. The eyes may appear normal, constricted, unequal, or dilated.

TABLE 7.3 Using the Mnemonic PEARL to Assess the Pupils

LETTER	ASSESSMENT
P	Pupils: Are pupils the same shape?
E	Are the pupils equal to one another?
A	Active: Can the patient smoothly track an object with both pupils?
RL	React to light: (pupillary light reflex). When a light is shone on the pupil, does it respond appropriately?

Eye movement is tested by asking the individual to focus on a single object. An individual experiencing **diplopia** sees two images instead of one. This condition is attributed to failure of the external eye muscles to work in a coordinated manner. The tracking ability of the eyes can be assessed by asking the individual to follow the clinician's fingers as they move through the six cardinal fields of vision. The individual's depth perception can be assessed by placing a finger several inches in front of the individual and then asking the person to reach out and touch the finger. This assessment should be repeated several times, with the clinician's finger in several different locations.

The athletic trainer should assess the scene and perform a primary survey of the gymnast. The gymnast is conscious and can relate to you what happened and where the pain is located. Inspection and palpation reveal no gross deformity, whereas assessing the integrity of the joint structures found negative results. All vital signs were normal, but the patient did have difficulty with eye tracking and exhibited sensitivity to light. The patient may have sustained a concussion and should be more specifically assessed for the presence of a possible concussion. What action(s) should you do next?

DISPOSITION

Depending on the severity of findings in any acute injury, what options for treatment does the athletic trainer have?

Information gathered during the assessment must be analyzed, and decisions

should be made based on the best interests of the injured individual. It is especially important to determine whether the situation can be handled on site or whether a referral to a physician is warranted. As a general rule, the individual should always be referred to the nearest trauma center or emergency clinic if any life-threatening situation is present, if the injury results in a loss of normal function, or if no improvement is seen in injury status after a reasonable amount of time. Examples of these injuries are provided in **Box 7.3**. Other conditions that are not necessarily life threatening but are serious enough to warrant referral to a physician for immediate care include the following:

- Eye injuries
- Dental injuries in which a tooth has been knocked loose or out
- Minor or simple fractures
- Lacerations that might require suturing
- Injuries in which a functional deficit is noticeable
- Loss of normal sensation or diminished or absent reflexes
- Noticeable muscular weakness in the extremities
- Any injury if you are uncertain about its severity or nature

Information gathered through the injury assessment will determine what course of action should be taken by the athletic trainer. An injured patient may be treated on site, monitored for changes in signs and symptoms, or referred to the emergency department. Conditions such as altered level of consciousness, impaired CNS function, or life-threatening bleeding warrant activation of EMS.

MANAGEMENT OF BONE INJURIES

What signs and symptoms indicate that a possible fracture is present? What standard of care is necessary to treat this potentially serious

injury?

Possible fractures can be detected with palpation, percussion, use of a tuning fork (vibrations), compression, and distraction (see Fig. 6.2). Palpation can detect deformity, crepitus, swelling, or increased pain at the fracture site. Percussion uses a tapping motion of the finger over a bony structure. A tuning fork works in the same manner; vibrations travel through the bone and cause increased pain at a fracture site. Compression is performed by gently compressing the distal end of the bone toward the proximal end or by encircling the body part (e.g., a foot or a hand) and gently squeezing, thereby compressing the heads of the bones together. Again, if a fracture is present, pain increases at the fracture site. Distraction employs a tensile force, whereby the application of traction to both ends of the fractured bone helps to relieve pain.

A suspected fracture should be splinted before the individual is moved to avoid damage to surrounding ligaments, tendons, blood vessels, and nerves. Application Strategy 7.2 explains the immediate management of fractures.

APPLICATION STRATEGY 7.2

Management Algorithm for Bone Injuries

1. Remove clothing and jewelry from around the injury site. (Cut clothing away with scissors to avoid moving the injured area.)
2. Check distal pulse and sensation. If either is abnormal, activate.
3. Cover all wounds, including open fractures, with sterile dressings and secure them.
4. Do not attempt to push bone ends back underneath the skin.
5. Pad the splint to prevent local pressure.
6. Apply minimal in-line traction and maintain it until the splint is in place and secured.
7. Immobilize the joints above and below the fracture site.
8. Splint in the position found if:
   - Pain increases with gentle traction or the limb resists positioning.

- The fracture is severely angulated.
- Do not straighten unless it is absolutely necessary to incorporate the limb into the splint; move as little as possible.
- Splint firmly but do not impair circulation.
- Recheck distal pulse and sensation after applying splint.
- Check vital signs, treat for shock, and transport to medical facility.

Signs and symptoms indicating a possible fracture include deformity, crepitus, swelling, or increased pain at the fracture site. The joint above and below the suspected fracture site should be immobilized in an appropriate splint.

EQUIPMENT CONSIDERATIONS

In sports such as football, ice hockey, and lacrosse, equipment may hinder a full assessment of an injury. What can be done to expose the area without causing additional pain to the athlete?

One of the primary concerns during an on-site assessment of an injured individual is that of equipment. If the injured body part cannot be adequately inspected with protective gear in place, the next option is to use palpation to check for the presence of deformity, point tenderness, fever, swelling, and crepitus. To protect both you and the patient, gloves should be worn when palpating areas that cannot be visually inspected first. Protective equipment can be removed but should be done so in a manner that causes the least amount of movement. Often, clothing and straps must be cut in order to remove the equipment and access the injury site.

When dealing with potentially life-threatening injuries, such as traumatic spinal cord injury, helmets and shoulder pads create potential barriers to providing appropriate care. The 2015 Task Force on the Appropriate Prehospital Management of the Spine-Injured Athlete developed 14

recommendations for health care providers when dealing with on-field management of athletes with potential spinal cord injury.[10] All 14 recommendations are listed in **Box 7.4**. However, the actual consensus statement should be read in its entirety to ensure in-depth understanding.

BOX 7.4 The Task Force on the Appropriate Prehospital Management of the Spine-Injured Athlete: 2015 Recommendations

Recommendation 1: It is essential that each athletic program have an EAP developed in conjunction with local EMS.

Recommendation 2: It is essential that sports medicine teams conduct a "time out" before athletic events to ensure EAPs are reviewed and to plan the options with the personnel and equipment available for that event.

Recommendation 3: Proper assessment and management of the spine-injured athlete-patient will result in activation of the EAP in accordance with the level or severity of the injury.

Recommendation 4: Protective athletic equipment *may* be removed prior to transport to an emergency facility for an athlete-patient with suspected cervical spine instability.

Recommendation 5: Equipment removal should be performed by at least three rescuers trained and experienced with equipment removal at the earliest possible time. If fewer than three people are present, the equipment should be removed at the earliest possible time after enough trained individuals arrive on the scene.

Recommendation 6: Athletic protective equipment varies by sport and activity, and styles of equipment differ within a sport or activity. Therefore, it is essential that the sports medical team be familiar with the types of protective equipment specific to the sport and associated techniques for

removal of the equipment.

Recommendation 7: A rigid cervical stabilization device should be applied to spine-injured athlete-patients prior to transport.

Recommendation 8: Spine-injured athlete-patients should be transported using a rigid immobilization device.

Recommendation 9: Techniques employed to move the spine-injured athlete-patient from the field to the transportation vehicle should minimize spinal motion.

Recommendation 10: It is essential that a transportation plan be developed prior to the start of any athletic practice or competition.

Recommendation 11: Spine-injured athlete-patients should be transported to a hospital that can deliver immediate, definitive care for these types of injuries.

Recommendation 12: It is essential that prevention of spine injuries in athletics be a priority and requires collaboration between the medical team, coaching staff, and athletes.

Recommendation 13: The medical team must have a strong working knowledge of current research as well as national and local regulations to ensure up-to-date care is provided to the spine-injured athlete-patient.

Recommendation 14: It is essential that future research continue to investigate the efficacy of devices used to provide SMR.

Adapted from National Athletic Trainers' Association. Appropriate prehospital management of the spine-injured athlete. Update from 1998 document. Retrieved from http://www.nata.org/sites/default/files/Executive-Summary-Spine-Injury-updated.pdf. Accessed November 17, 2015.

The Task Force advocates for **removal of protective equipment** *prior* to

transporting the athlete to the emergency department; in other words, the equipment comes off on the field. Removal of helmets and shoulder pads is recommended in order to provide immediate access to the airway and chest in the event cardiopulmonary resuscitation (CPR), automated external defibrillator (AED), or the administration of oxygen is needed. Guidelines for the removal of any piece of protective equipment should be defined within the emergency medical plan.

Helmet Removal

Only qualified medical personnel with training in equipment removal should attempt to remove equipment.[10] Three trained individuals are needed to carry out the task. One individual maintains in-line stabilization of the head, neck, and helmet while another person cuts the chin strap. Next, while one assistant continues to maintain stabilization of the chin and back of the neck, the other individual removes any accessible internal helmet padding, such as cheek pads. In removing the pads, a flat object, such as a tongue depressor or the flat edge of tape scissors, can be slid between the helmet and the pad. A slight turn of the inserted object causes the pad to unsnap from the helmet. If an air cell–padding system is present, the system should be deflated by releasing the air at the external port with an inflation needle or a large gauge hypodermic needle. The helmet should then be slid off the occiput with slight forward rotation of the helmet. If the helmet does not move with this action, slight traction can be applied to the helmet as it is carefully rocked anteriorly and posteriorly, with great care being taken not to move the head and neck unit. The helmet should not be spread apart by the ear holes because this only serves to tighten the helmet on the forehead and occiput region.[10] **Application Strategy 7.3** demonstrates the basic steps in the removal of a football helmet.

APPLICATION STRATEGY 7.3

Removal of Protective Equipment

1. One individual maintains in-line stabilization of the head, neck, and

helmet to minimize cervical spine movement. This can be accomplished by applying an in-traction force through the patient's chin and occiput, in a cephalad direction, making sure to maintain the athlete's position. Cut the jersey from the neck to the waist and from the midline to the end of each sleeve. Cut all straps used to secure the pads to the torso and arms (Fig. A). Attempting to unbuckle the straps may cause unnecessary movement. Cut the laces over the sternum and then cut and/or remove any accessory such as a neck roll or collar.

2. Another individual cuts the chin strap. A flat object is slid between the helmet and cheek pad. The object is then to be twisted to unsnap and separate the cheek pad from the helmet. Repeat on the other side and remove both cheek pads (Fig. B). If an air cell–padding system is present, deflate the system by releasing the air at the external port with an inflation needle or large gauge hypodermic needle.

3. The captain, the in-charge responder, maintains cervical stabilization in a cephalad direction by placing his or her forearms on the patient's chest while holding the chin and occiput (Fig. C).

4. Slide the helmet off the occiput with a slight forward rotation of the helmet. If the helmet does not move, slight traction can be applied to the helmet and a gentle anterior and posterior maneuver may be applied, although the head/neck unit must not be allowed to move (**Fig. D**).

5. Assistants on either side of the patient place their hands directly under the thoracic region of the back. Additional support is placed down the body as deemed appropriate based on the size of the patient. While the patient is lifted, the individual in charge of head/shoulder stabilization should remove the helmet (if not already done) and then immediately remove the shoulder pads by spreading apart the front panels and pulling them around the head (**Fig. E**).

6. In-line stabilization is maintained while the athlete is prepared for movement onto a scoop stretcher (Fig. F).

Adapted from: Kleiner DM, Almquist JL, Bailes J, et al. *Prehospital Care of the Spine-Injured Athlete: A Document from the Inter-Association Task Force for Appropriate Care of the Spine-Injured Athlete*. Dallas, TX: Inter-Association Task Force for Appropriate Care of the Spine-Injured Athlete; 2001.

Shoulder Pad Removal

Shoulder pads *may be removed* in the presence of a suspected spinal cord injury, respiratory distress, and/or cardiac distress. The chest is exposed by cutting the shirt from the neck to the waist and from the midline to the end of each arm sleeve. Next, all straps securing the shoulder pads to the arms are cut, the laces or straps over the sternum are cut, and the two halves of the shoulder pads are spread apart. All accessories, such as neck rolls or collars, are then cut and/or removed. One individual maintains cervical stabilization in a cephalad direction by placing his or her forearms on the athlete's chest while manually stabilizing the chin and occiput. Assistants should be positioned on

each side of the athlete with their hands placed directly against the skin in the thoracic region of the back. Additional support should be provided at other strategic locations down the body as deemed appropriate for the size of the patient. While the patient is lifted, the individual in charge of the head/shoulder stabilization should remove the helmet and then immediately remove the shoulder pads by spreading apart the front panels and pulling them around the head. Next, the remaining jersey and any other accessories are removed, and the patient is lowered, with appropriate immobilization being continued.[11] Guidelines for removing shoulder pads are presented in **Application Strategy 7.3**.

Protective equipment should be removed prior to transporting the athlete to the emergency department. This is recommended in order to provide immediate access to the airway and chest in the event CPR, AED, or the administration of oxygen is needed.

MOVING THE INJURED PARTICIPANT

What criteria should be used to determine whether an injured individual should be allowed to walk off the field or site of the injury? What is the safest method for transporting an individual with a lower extremity injury?

Once the extent and severity of the injury have been determined, a decision must be made regarding how to safely remove the individual from the area. Possible methods include ambulatory assistance, manual conveyance, and transport by a stretcher or spine board.

Ambulatory Assistance

Ambulatory assistance is used to aid an injured individual who is able to walk. This implies that the injury is minor and no further harm will occur if the

individual is ambulatory. In performing this technique, two individuals of equal or near equal height should support both sides of the individual. The injured individual drapes his or her arms across the shoulders of the assistants while the arms of the assistants encircle the injured person's back. This position enables the assistants to escort the individual to an appropriate area for further evaluation and treatment.

Manual Conveyance

If the individual is unable to walk or the distance is too great to walk, manual conveyance should be used. The individual continues to drape his or her arms across the assistants' shoulders while one arm of each assistant is placed behind the individual's back and the other arm is placed under the individual's thigh. Both assistants lift the legs up, placing the individual in a seated position. The individual is then carried to an appropriate area (**Fig. 7.5**). Again, it is essential that the injury be fully evaluated before moving the individual in this manner.

Figure 7.5. Manual conveyance: chair carry.

Transport by Rigid Immobilization Device

When dealing with a potential spinal cord injury, the **goal is spinal motion restriction (SMR)** and not immobilization of the spine. SMR is intended to prevent further injury to the spine by reducing as much motion as possible.[10] The Task Force on the Appropriate Prehospital Management of the Spine-Injured Athlete recommends the following criteria when considering using SMR: (1) blunt trauma with altered level of consciousness, (2) spinal pain or tenderness, (3) neurological complaint (e.g., numbness or motor weakness), and (4) anatomical deformity of the spine. SMR is also recommended when there is a high-energy mechanism of injury and with any of the following: (1) drug or alcohol intoxication, (2) inability to communicate, and (3) a distracting injury.[10]

Due to the potentially harmful effects of being placed on the traditional long spine board for prolonged periods of time, it is recommended that

alternative rigid immobilization devices be considered in place of the long spine board, such as a vacuum mattress or scoop stretcher.[10,12] Best practices now recommend using an 8-person team to lift the supine athlete onto the immobilization device.[10] Guidelines for using a scoop stretcher to lift a supine patient from the field can be seen in **Application Strategy 7.4**. Log rolls may be used to position the athlete onto the scoop stretcher spine board when the patient is found in a prone position. Once the patient is secured on the rigid immobilization device, the stretcher is raised to waist level. The individual should be carried feet first so that the captain, or person at the patient's head, can constantly monitor the individual's condition.

APPLICATION STRATEGY 7.4

Transporting an Injured Individual on a Scoop Stretcher

Unless ruled out, assume the presence of a spinal injury.

1. The captain of the response team maintains manual in-line stabilization. A second member of the response team applies a rigid cervical collar to the patient as soon as possible. Manual in-line stabilization is maintained until the patient has been stabilized on the scoop stretcher and a head immobilization device has been applied (**Fig. A**).

2. The scoop stretcher is placed beside the patient to determine the appropriate length. The scoop stretcher is then extended to accommodate the height of patient. The scoop is unlatched at the top and bottom and separated into two sides. One side is placed on either side

of the patient (Fig. B).

3. The top latch is then secured, and the two sides are drawn together until the bottom latch is secured and the patient is resting on top of the stretcher.
4. The patient's body is first secured to the scoop stretcher followed by using a head immobilization device to secure the head to stretcher. All voids should be filled with soft material, such as towels. Straps are then tightened (Fig. C).

Patients who are able to walk should be assisted off the field using an ambulatory assist. For those who are unable to bear weight on the lower extremities, manual conveyance may be used to carry them off the field. Patients who have a suspected spinal cord injury, fracture, or other condition where they need to be quickly removed from the field should be transported using a scoop stretcher or vacuum mattress.

PREVENTING SUDDEN DEATH IN ATHLETICS

A high school field hockey player suddenly collapses on the turf during practice. No known contact occurred with any other player or equipment. What immediate actions should you take? What possible conditions may lead to sudden death in sport?

In order to prevent sudden death in athletics, one must be able recognize when a potential sudden death event is occurring and know the appropriate response to either prevent the event or minimize the extent of damage. There

are a variety of causes of sudden death in sport activities. Many of the strategies already addressed in Chapter 2 (Preparticipation Examination) and earlier in this chapter ("The Emergency Action Plan" section) are intended to help prevent or minimize the risk. Within this section, brief focus will be on the 10 conditions covered in the National Athletic Trainers' Association (NATA) position statement on preventing sudden death in athletics[10] from an early recognition and emergency medical response perspective. More in-depth information on each condition is provided in later chapters.

Asthma

Athletes who have a history of asthma should be monitored for signs of acute asthma exacerbation. **Mild acute asthma exacerbation** (or asthma attack) occurs when the patient has mild **dyspnea** during activity. They may experience wheezing or coughing. The patient's peak expiratory flow (PEF) is equal or greater than 70% of the baseline (determined during preparticipation examination). Patients experiencing a mild asthma attack should be removed from activity and directed to self-administer short-acting β_2-agonist medication. Known as rescue inhalers, a commonly used bronchodilator medication is albuterol.

A patient experiencing a **moderate acute asthma exacerbation** presents with more pronounced wheezing, coughing, decreased ability to speak, inability to continue participation, and a PEF that is between 40% and 69% of the baseline. Patients experiencing a moderate asthma attack should be removed from activity and the environment triggering the attack. The patient is directed to use the rescue inhaler and should be monitored. If SpO_2 levels are below 95%, oxygen should be administered. If the patient does not respond relatively quickly after three bronchodilator treatments, refer to the nearest health center for more advanced treatment.

Severe acute asthma exacerbation is experienced with a PEF of less than 40% of baseline. The patient may be unable to speak and coughs frequently. Activity is impossible. In some cases, the patient may be drowsy, confused, or cyanotic. Administer the rescue inhaler and oxygen and either

activate EMS or refer the patient to the nearest health care facility.[13,14]

Catastrophic Brain Injuries

A blow to the head may result in a focal brain injury such as a hematoma, cerebral contusion, or intracranial bleeding or in a diffuse brain injury such as cerebral concussion, diffuse cerebral swelling, or diffuse axonal injury.[15] Second impact syndrome (SIS), a type of diffuse brain injury, is precipitated by an earlier event where a patient sustains a concussion which is unresolved. If, while in this postconcussive state, the patient receives a second blow to the head, SIS may result. Diffuse cerebral swelling and brainstem herniation occurs.[16] This cascade of events can occur in 3 to 5 minutes from the time the patient receives the blow.[17] Although diffuse brain injuries and focal brain injuries will not present exactly the same, there are several red flags indicative of traumatic brain injury that necessitate immediate and accurate response to prevent death from occurring (Table 7.4).

TABLE 7.4 Red Flags Indicating Presence of Traumatic Brain Injury

SYSTEM	FINDING[a]
LOC	1. AVPU less than "A" 2. GCS <9 3. Initial loss of consciousness following by lucid period followed by a gradual decline in mental status 4. Gradual decline in mental status, LOC 5. Coma 6. Convulsions
Reflex	(+) Babinski (+) Oppenheim
Blood pressure	Rising blood pressure
Pulse	Rapid, weak or falling pulse
Respiration	Irregular or abnormal breathing patterns
PEARL	Pupils unequal, inability to track or react to light

[a]All findings need to be present to suspect presence of TBI.
LOC, level of consciousness.

The first step in providing appropriate care is recognizing that the patient has sustained a traumatic brain injury and immediate activation of the EAP and summoning EMS is imperative. For patients with a Glasgow Coma Scale of less than 9 and an SpO_2 level of less than 90%, supplemental oxygen should be administered while waiting for EMS to arrive.[18] Otherwise, maintain an open airway, monitor level of consciousness and the ABC, assess all vital signs, and

treat for shock.

Cervical Spine Injuries

There are seven cervical vertebrae and eight cervical nerve roots extending from the upper most region of the spinal cord. Nerve roots C1–C4 control a person's ability to breathe as well as the bladder/bowel functions and use of the limbs. If this portion of the spinal cord is damaged, the person may become quadriplegic and need assistance in breathing. In some cases, if care is not rendered quickly, the damage may result in death. If the spinal cord is damaged between C5 and C8, the person will be able to breathe on his or her own but will have decreased function of portions of the arms and/or legs. Injury to the cervical spinal cord should be suspected when the athlete is unconscious or has an altered level of consciousness, presents with bilateral neurological symptoms or dysfunction such as diminished dermatome response, weakness during myotome testing, and poor reflexes.

Athletes who complain of unprovoked neck pain or who are tender upon palpation of the cervical vertebrae should be treated for a potential spinal cord injury. The EAP should be implemented and EMS activated at once. In-line stabilization of the cervical region should be administered without applying traction.[13] Access to the airway and chest should be provided, and the patient should be stabilized and transported as described previously in this chapter.[10]

Diabetes Mellitus

The definition, cause, and pathophysiology of diabetes are discussed in great detail later in this text. From an acute recognition and treatment perspective, it is important to know that mild hypoglycemia can be treated on site; however, severe hypoglycemia may lead to unconsciousness and death and is considered a medical emergency that requires the immediate activation of EMS.[10] Signs and symptoms of hypoglycemia include increased heart rate, sweating, palpitations, hunger, nervousness, headache, trembling, dizziness, or, in severe cases, unconsciousness.[10] A blood sugar level between 60 and 70 mg per dL is considered mild hypoglycemia.

Because glucose levels in the blood are low compared to high levels of insulin, treatment focuses on getting 10 to 15 g of a fast-acting carbohydrate into the system quickly. This can be found in 4 oz (½ cup) of juice or regular soda, 1 tablespoon of honey or corn syrup, 2 tablespoons of raisins, 4 packets or 4 teaspoons of sugar, and four or five saltine crackers.[19] Chocolates, which contain a high level of fat, should not be used for treating a hypoglycemic reaction because the fat interferes with the absorption of sugar. After initial recovery, the individual should wait 15 minutes and check the blood sugar level. If the level is still less than 70 mg per dL or no meter is available and the individual still has symptoms, another 10 to 15 g of carbohydrates should be administered. Blood testing and treatment should be repeated until the blood glucose level has normalized. Even when the blood glucose level has returned to normal, however, physical performance and judgment may still be impaired, or the individual may relapse if the quick sugar influx is rapidly depleted. After the symptoms resolve, the individual should be instructed to have a good meal as soon as possible to increase carbohydrates in the body.

Blood glucose levels below 40 mg per dL is considered severe hypoglycemia, and EMS should be activated.[10] If the person is unconscious or unable to swallow, the individual should be rolled on his or her side so close attention can be given to the airway so that saliva drains out of the mouth, not into the throat. Sugar or honey should be placed under the tongue because it is absorbed through the mucous membrane. Patient's ABC, level of consciousness, and vitals should be monitored while waiting for EMS to arrive.[10]

Exertional Heat Stroke

Exertional heat stroke (EHS) is among the top three causes of death in sports and occurs more often during the hotter months.[10] EHS is identified through the presence of two criteria, core body temperature of greater than 104° to 105°F and CNS dysfunction (**Table 7.5**). Because successful treatment requires that the core body temperature be dropped to 102°F within 30 minutes of collapse, it is essential to obtain an accurate measurement of the core temperature via

rectal or ingestible thermometers. The longer the length of time the core temperature remains above 105°F, the greater the risk of death and permanent damage. EMS should be activated as soon as EHS is suspected. The patient should be immersed in cold (35°F) moving water. A rectal probe or ingestible thermometer should be in place to monitor core temperature during the cooling process. The patient should not be removed from the cold water immersion until the core temperature reaches 102°F. At this point, the patient should be transported via EMS to the nearest medical center. If cold water immersion is not an option, the patient should be covered in cold wet towels and have cold water continuously poured onto the towels. Fans may be used to assist in the cooling process.[10]

TABLE 7.5 Central Nervous System Dysfunction and Signs/Symptoms Associated with Exertional Heat Stress

CNS DYSFUNCTION	ADDITIONAL SIGNS AND SYMPTOMS
Disorientation	Core body temperature greater than 104°F
Confusion	Dehydration
Dizziness	Hot, sweaty skin as opposed to the dry skin that is a manifestation of classical EHS
Vomiting	Hypotension
Diarrhea	Hyperventilation
Loss of balance	
Staggering	
Irritability	
Irrational or unusual behavior	
Apathy, aggressiveness	
Hysteria, delirium	
Collapse, loss of consciousness, coma	

Adapted from National Athletic Trainers' Association. Appropriate prehospital management of the spine-injured athlete. Update from 1998 document. Retrieved from http://www.nata.org/sites/default/files/Executive-Summary-Spine-Injury-updated.pdf. Accessed November 17, 2015.

Exertional Sickling

Exertional sickling occurs in athletes who have *sickle cell trait*. **Exertional sickling** is when a red blood cell (RBC) changes shape from round to sickle or half-moon shape. The sickled RBCs clump together, in essence causing a log jam in the small blood vessels, leading to decreased blood flow and a break down in the muscle tissue and death.[20] If proper intervention and treatment strategies are not employed, exertional sickling may result in death. Exertional

sickling is often confused with exertional heat cramps, and comparisons of the two are presented in Table 7.6. Exertional sickling should be suspected if the patient has sickle cell trait and shows signs of fatigue, difficulty breathing, leg or low back pain, and leg or low back cramps.[20] The patient should be immediately removed from activity, administered high flow oxygen at 15 L per minute using a nonrebreather face mask and the EAP should be activated.[10] Continue administering oxygen and monitoring vitals until EMS arrives on the scene.

TABLE 7.6 How Exertional Hat Cramping Differs from Exertional Sickling

EXERTIONAL CRAMPING	EXERTIONAL SICKLING
Muscle twinge prior to onset of cramping	No muscle twinging prior to cramping
Extremely painful muscle cramping	Muscle cramping present, limited pain
Athlete "hobbles to ground" due to cramps	Athlete "drops to ground" due to weakness
Muscular cramps visible, athlete in obvious pain	Musculature appears normal, athlete will be relatively quiet.

Lightning Injury

Most injuries from lightning can be prevented by having a lightning policy in place and following it. In the event a patient is struck by lightning, quick action is needed to save lives. Patients who have been struck by lightning are safe to touch but precaution should be taken to ensure the safety of the athletic trainer who is providing care. If multiple persons have been struck, triage patients and assist those with no cardiac activity first. In other words, those who appear to be dead should be treated first. Most deaths from lightning strikes are the result of cardiac arrest; therefore, it is essential to start CPR and utilize an AED if indicated. EMS should be activated immediately. Monitor the patients until EMS arrives.

Sudden Cardiac Arrest

There are multiple underlying reasons, as well as specific traumatic causes, which might result in sudden cardiac death during athletics. These factors will be examined fully in later chapters. However, it is important to be able to recognize when sudden cardiac arrest (SCA) has occurred, one must respond appropriately. SCA should be *suspected* in any patient who collapses and is

unresponsive. An assessment of the patient's ABC should be conducted and AED shock applied if indicated. The EAP should be initiated immediately. CPR and an AED should be provided and utilized as indicated, and the patient's vital signs should be continually monitored until EMS arrives.

The high school field hockey player who suddenly collapsed on the turf during practice may have suffered from SCA. Immediately initiate the EAP and begin CPR. Apply an AED shock if indicated and continue treatment until the EMS arrives.

SUMMARY

1. In consultation with the supervising physician and local EMS agencies, the athletic trainer should coordinate the development of an emergency plan. The purpose of this plan is to ensure rapid and complete emergency care to an injured individual. The plan should be evaluated annually and should be practiced by all parties on a regular basis.
2. In an emergency injury assessment, the presence of a head or spinal cord injury should be assumed. As such, the head and neck should be stabilized before proceeding. The assessment of all injuries, no matter how minor, should include a primary injury assessment to determine the level of responsiveness and to assess the ABC. A secondary assessment determines the presence of moderate to severe injuries.
3. As a general rule, an individual should always be referred to the nearest trauma center or emergency clinic if any life-threatening situation is present or if the injury results in a loss of normal function.
4. The secondary assessment should follow a logical progression to elicit important information in order to determine the appropriate response. The sequence includes history, palpation, and special.
5. The use of a variety of laboratory tests and imaging techniques can be instrumental in establishing an accurate diagnosis of an injury or illness.

In the majority of cases, these tests can only be ordered by a physician or appropriately licensed medical specialist.

6. In the presence of suspected fracture, the area should be immobilized and referred for evaluation by a physician.
7. Protective equipment should be removed if equipment impairs your ability to properly assess the patient or inhibits the ability to provide proper care, as in the case of head or neck injury.
8. When dealing with suspected cervical spine injury, manual in-line stabilization is applied and a cervical collar is utilized. The patient should be secured to a rigid splint and transported to a medical facility. A long spine board should be used only as a last resort.
9. Sudden death in athletics can be prevented by the ability to quickly recognize conditions leading to sudden death and providing the appropriate response immediately. Early activation of the EMS is an essential component of providing appropriate care.

APPLICATION QUESTIONS

1. As the first full-time athletic trainer at a coeducational high school that fields 16 interscholastic teams, the athletic director has instructed you to form a committee to develop an EAP for use at the various venues of the facility. When looking at potential committee members, who would you most likely want on this committee and would each of these individuals be critical in developing the school's EAP?
2. What information should be included with the EAP? How should the plan be adapted for each of the different venues where activities take place? What information should be provided to the dispatcher once the EAP has been initiated?
3. How does the assessment of an acute on-field injury differ from conducted on a patient who complains of long-term pain and discomfort with no

known cause. How do you go about ruling out life-threatening conditions during the on-field assessment? If no life-threatening conditions are present, what is your order of exclusion or triage?

4. How can vital signs assist you in assessing the presence of nonorthopedic injury? Why is it important to include a vital sign assessment? What other diagnostic information can be obtained through clinical examination during an on-field or sideline evaluation?
5. You suspect a men's lacrosse player has sustained a cervical spine injury. How should this injury be managed on field?

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