# MODULE V

# TRAUMA

# LEARNING OBJECTIVES

Upon completion of this course, the student will be able to:

1. Provide care to a patient in shock (hypoperfusion).
   o State methods of emergency medical care of external bleeding.
   o List signs and symptoms of shock (hypoperfusion).
   o State the steps in the emergency medical care of the patient with signs and symptoms of shock (hypoperfusion).
2. Provide care to a patient with a suspected spinal injury.
   o State the signs and symptoms of a potential spine injury.
   o Describe how to stabilize the spine.
3. Provide care to a patient with a suspected head injury.
   o Relate mechanism of injury to potential injuries of the head and spine.
4. Provide care to a patient with a soft-tissue injury.
   o Describe the emergency medical care of the patient with a closed soft tissue injury.
   o Describe the emergency medical care of the patient with an open soft tissue injury.
5. Perform a rapid extrication of a trauma patient.
   o Describe the indications for the use of rapid extrication.
   o List steps in performing rapid extrication.

Every day thousands of people become the accidental victims of trauma. Approximately 43,000 people die in motor vehicle crashes each year in the United States. With an estimated 2.9 million people injured in these accidents, the impact on the EMS system is significant. Head-on collisions account for approximately 11% of all fatal accidents (NHTSA, 2004). Such collisions commonly produce lower-extremity injuries to the knees, femurs, and hips, as well as chest and abdominal injuries from impact with the steering wheel or airbag.

Trauma is the leading cause of death in the United States for persons between the ages of 1 and 44. Understanding the mechanism of injury, relevant signs and symptoms, and appropriate intervention techniques is essential when dealing with the traumatized patient. Airbags have reduced the incidence of significant head injuries for restrained drivers; however, drivers are still at risk for cervical spine and head injuries in this type of collision.

Rear-end collisions generally do not cause fatal injuries; however, they commonly result in cervical spine injuries caused by the neck's hyperextending—when the occupant is propelled forward by the force of the accident—and then snapping back (whiplash). Properly adjusted head rests are designed to reduce the incidence and severity of neck injuries.
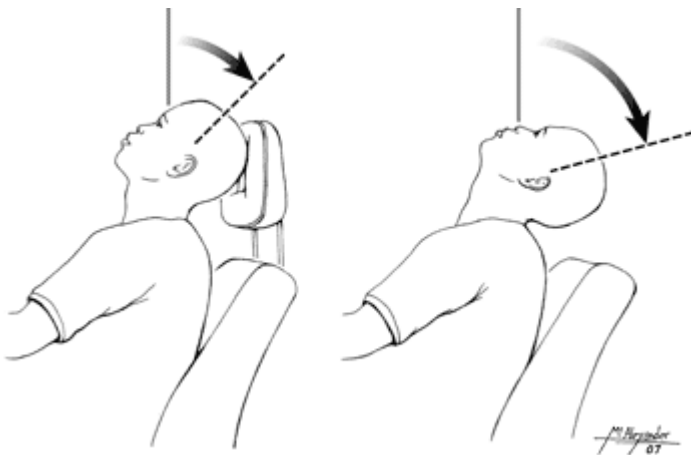


Driver experiencing whiplash.

Lateral and side-impact collisions occur less frequently but they are the most serious, resulting in approximately 24% of all traffic-related fatalities (NHTSA, 2004). In a lateral or side-impact collision, the amount of structural steel between the occupant and the impacting vehicle is markedly less than for frontal or rear-end collisions, and this frequently results in significant internal injuries. Both upper- and lower-extremity injuries may occur on the impacted side, as well as head and cervical spinal injuries.

When a vehicle is struck from an oblique angle, the vehicle rotates as a result of the collision. This is referred to as a rotational impact. Though the damage to the vehicle may be significant in these types of collisions, they generally do not result in significant

injuries to the occupant because they do not cause the vehicle to stop suddenly; instead, the vehicle comes to rest more slowly, resulting in fewer deceleration injuries.

Rollover collisions result in approximately 22% of annual traffic fatalities. Significant injuries may result based on the number of impacts associated with the rollover and whether the occupant was restrained. The greatest risk associated with rollover collisions is that of being partially or fully ejected from the vehicle if occupants are improperly restrained.

The use of seatbelts has steadily increased over the past twenty years, with many states enacting strict laws governing their use. With the exception of public transportation, most states require seatbelt use for all front-seat occupants. In some states however, seatbelt violations are considered secondary violations, meaning that an officer can only enforce seatbelt laws when the driver has been pulled over for a violation of another law. The NHTSA estimates that the use of manual three-way seatbelts reduces the risk of death in motor vehicle collisions by 45% for front-seat occupants.

In 1995 approximately 84% of all new cars sold were equipped with dual air bags for the driver and front-seat passenger. In frontal collisions, which represent the primary collision type for which airbags were designed to reduce injury, drivers with airbags had a reduced fatality rate of 21% (NHTSA, 1996).

Since the widespread use of airbags began in the mid-1990s, just under 300 adults and children have died as a result of their use. In that same period it is estimated that 20,000 lives have been saved by using airbags. New technology for airbags, coupled with public awareness campaigns, has resulted in more infants and children being secured in the rear seat, away from airbags, further reducing fatalities.

Injuries associated with airbags are related to the speed with which the devices inflate, and are usually limited to superficial injuries to the upper extremities. This does not apply to infants or children in the front seat; significant airbag injuries can result from placing infants in rear-facing child seats or children under age 12 or less than 100 pounds in front passenger seats.

In 2004 an estimated 70,000 pedestrians were injured in motor vehicle collisions and approximately 4,600 pedestrians were killed by motor vehicles (IIHS, 2005). Most pedestrians are struck by the front of the vehicle, and they are generally at fault in these types of accidents. Nevertheless, many accidents, most of which involve children, are events in which pedestrians are backed into or over by a vehicle. The speed of the vehicle at impact, the size of the pedestrian, and the height of the vehicle all factor significantly in the injury patterns noted on these patients.

SCENARIO

At 2200 you are called to respond to a motor vehicle accident (MVA) on a rural two-lane highway. A helicopter is also being dispatched to transport any critical patient to the nearest trauma center, which is 45 miles away.

Witnesses report that traffic had stopped for a tractor crossing the road. A truck traveling at a high rate of speed failed to stop, lost control, and skidded off the roadway at 70 mph. The truck rolled and struck a tree, ejecting the occupant. You find a 22-year-old male unresponsive, lying 25 feet from the vehicle.

The patient is prone and motionless. While maintaining manual c-spine control, you and your partner log roll him onto his back. You maintain c-spine control while your partner palpates a carotid pulse of 100 bpm but is unable to palpate a radial pulse. You place a cervical collar on the patient's neck and then the two of you log roll the patient onto a long spine board and check for breathing.

The patient has a respiratory rate of 10, so your partner places an oropharyngeal airway (OPA) and begins ventilating the patient with a bag valve mask (BVM) using high-flow oxygen, while you do a quick assessment for uncontrolled bleeding. [Note: In your district you are authorized to intubate and start IVs.]

Your partner reports that it is becoming difficult to ventilate the patient due to blood and secretions in the airway. You suction and then intubate the patient to secure his airway. Your partner resumes ventilation with a BVM using high-flow oxygen.

After making sure the head and neck are stabilized and rest of the body is secured to the board, you load the patient into the back of the ambulance. The heater is turned up to keep him warm while you expose the body to assess for other injuries. While your partner ventilates the patient with high-flow oxygen, you complete a focused assessment.

You find that the patient has deformity to his upper right leg and a 3-inch laceration to the lower right leg with moderate bleeding. You learn that the helicopter will arrive in 10 minutes. You bandage the laceration with dry sterile dressings, place a traction splint on the deformed upper leg, initiate two large-bore IVs, and cover the patient to keep him warm. When the helicopter arrives, you hand off the patient to the helicopter crew.

# SHOCK (HYPOPERFUSION SYNDROME)

## Severity

To ensure normal perfusion of tissues, the human body must have:

- Adequate air exchange in the lungs to allow oxygen into the bloodstream
- An intact vascular system to delivery the oxygenated blood to the body's tissues
- An adequate volume of fluid, including red blood cells and plasma
- A functioning pump to circulate the volume
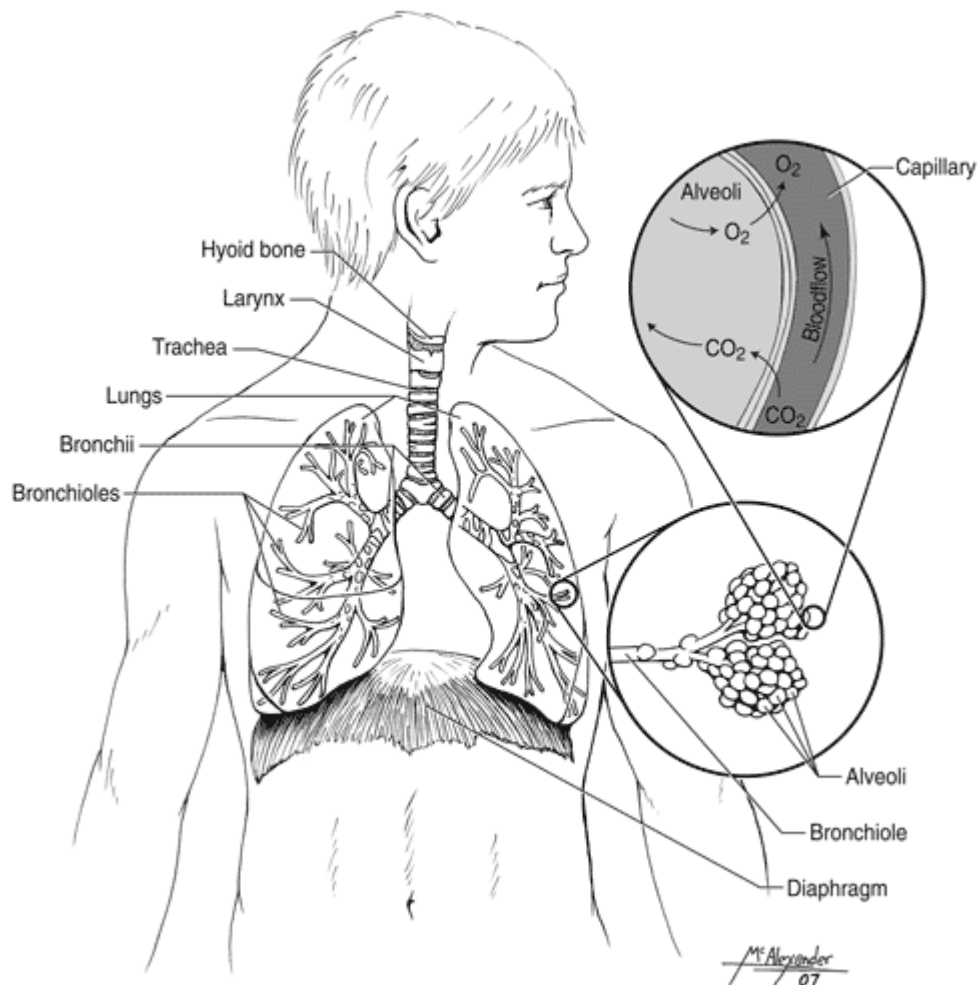
The lower airway, showing gas exchange.

In shock states, one or more of these components has been disrupted, causing inadequate tissue perfusion. Cell and organ malfunction and death can result from shock; therefore, prompt recognition and treatment is vital to patient survival.

Though the most common shock observed in trauma is related to hemorrhage, shock can be classified into three general categories (BTLS, 2004):

- **Low-volume shock** (absolute hypovolemia), caused by hemorrhage or other major body fluid loss
- **High-space shock** (relative hypovolemia), caused by spinal injury, vasovagal syncope, sepsis, and certain drug overdoses
- **Mechanical (obstructive) shock**, caused by pericardial tamponade, tension pneumothorax, or myocardial contusion

In the early stages of low-volume or hypovolemic shock, the body's sympathetic nervous system responds to a decrease in circulating volume by releasing catecholamines that cause an increase in heart rate and vasoconstriction. The body mounts this response in an attempt to maintain adequate blood flow to the brain and heart.

Peripheral vasoconstriction at this stage can cause the patient's skin to be cool and pale and capillary refill to slow. As low-volume shock progresses, the patient may show mental status changes indicating that the body's compensatory mechanisms are failing to perfuse the vital organs adequately. A late sign that the body is moving from a compensated shock state to a decompensated state is a drop in the patient's blood pressure.

High-space shock, commonly referred to as neurogenic shock, can be observed in patient's who have spinal cord injuries. This type of shock causes a disruption in the sympathetic nervous system, which prevents a catecholamine release and vasoconstriction in response to accompanying hemorrhage.

Patients with high-space shock present with different symptoms from those of a low-volume shock patients in that they will not exhibit an increased heart rate, cool and pale skin, or changes in capillary refill time. These patients generally exhibit pink, warm and dry skin, mild hypotension, relative bradycardia, and frequently have no changes in mental status, but they do have flaccid paralysis.

High-space shock states can be missed in the prehospital setting because these patients often do not appear to be critically injured. You must rely on evaluation of the mechanism of injury and a comprehensive neurologic assessment to determine the potential for underlying hemorrhage. If present, it may necessitate appropriate treatment such as fluid replacement, oxygen administration, and destination determination.

Normally the body circulates approximately five liters of blood per minute. In order to maintain this volume of distribution, the left side of the heart must be able to relax and contract sufficiently to pump the volume through the arterial system. Likewise, the right

side of the heart must be able to relax and contract sufficiently to accept the return of de-oxygenated blood from the venous system and push it out to the lungs to be re-oxygenated.

Mechanical shock can result from trauma to the chest, causing conditions such as tension pneumothorax and pericardial tamponade. A tension pneumothorax causes a shift in the structures of the mediastinum, which reduces venous return of blood. In pericardial tamponade, the space surrounding the heart fills with blood, which prevents the heart from filling and pumping adequately.
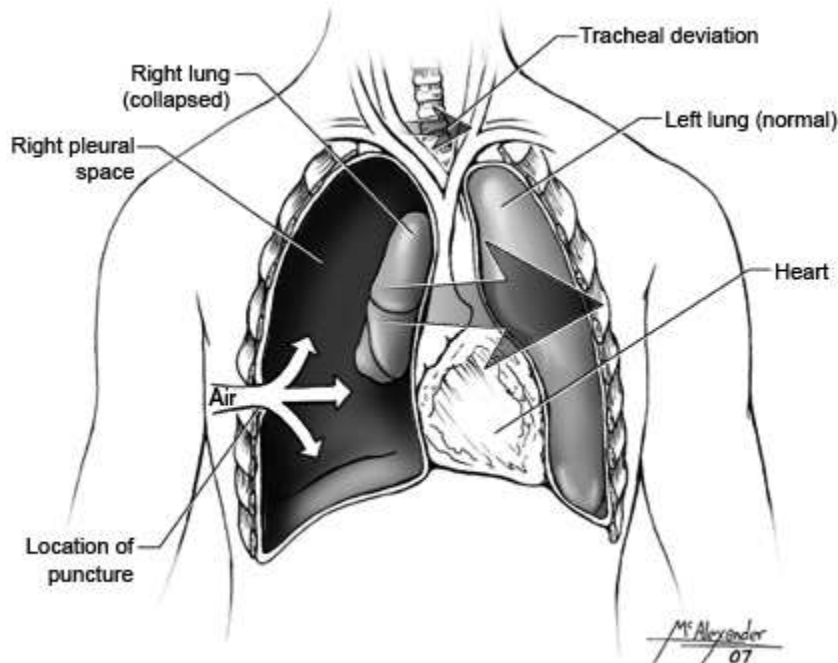


Pneumothorax resulting from trauma, showing the collapse of the lung due to air entering the pleural space. Note deviated trachea.

In order to choose the appropriate treatment modality it is important to be aware of all three types of shock when assessing a trauma patient. The foundation of good trauma care is developing a working diagnosis based on a thorough assessment of the mechanism of injury, the patient's age and medical history, presenting signs and symptoms, and the patient's response to treatment. Close attention paid to the patient's response may indicate a need to re-assess in order to respond appropriately to the patient's condition.

## Signs and Symptoms of Shock

The signs and symptoms of shock can be assessed in three ways: mental status, perfusion status and vital signs. As shock progresses, the signs exhibited by the patient will become more pronounced.

Class I hypovolemic shock is characterized by a fluid loss of up to 15%, or 750 ml of circulating volume. At this stage minimal signs of shock are present. Mental status is generally unchanged, skin signs are warm and dry, heart rate remains less than 100 bpm, and blood pressure and respiratory rate are within normal limits.

Class II shock represents a more significant volume loss of 15% to 30%, or up to 1500 ml of circulating volume. At this stage, patients may exhibit mental status changes such as restlessness or anxiety. The skin may become pale and cool with a delay in capillary refill, and both heart rate and respiratory rate increase.

A loss of 30% to 40% of the circulating volume, or 1500 to 2000 ml, represents profound shock. As the patient transitions into class III shock there will be marked anxiety and confusion. A further delay in capillary refill time, with increasing pallor and cool skin, are signs of advancing peripheral shut down. Blood pressure begins to drop, and heart and respiratory rates continue to increase as the body fights to survive. These are signs that the body's compensatory mechanisms are beginning to fail. Patients in class III shock who survive the initial insult often succumb to organ failure before discharge.

Class IV shock is the final stage of decompensated shock. The body has suffered a fluid loss of more than 2000 ml, or 40% of the total circulating volume. The patient becomes lethargic or unresponsive with cool, sometimes waxy skin. As the patient moves into class IV shock, the heart rate may be in excess of 140 bpm and is accompanied by profound hypotension. As the compensatory mechanisms continue to shut down, both the heart rate and respiratory rate begin to decrease (WNMEDS, 2004).

In addition to the signs and symptoms discussed earlier in this section, patients in shock may also exhibit dilated pupils as the result of stimulation of the sympathetic nervous system, and cyanosis to the lips, fingers, and toes as a result of peripheral vasoconstriction. Patients may also exhibit nausea and vomiting related to the catecholamine release.

You should have a very high index of suspicion for pediatric patients who have been involved in a traumatic event. Infants and children can maintain their blood pressure until their blood volume is more than half gone. However when pediatric patients start to show signs of decompensation, they deteriorate very rapidly.

Pediatric patients have less reserve than their adult counterparts, which will result in rapid exsanguination if there is major uncontrolled bleeding, and a shorter duration of time during which the body's fight-or-flight mechanism will maintain vital functions in the presence of significant traumatic injuries. By the time hypotension ensues, the pediatric patient may be near death.

# Emergency Medical Care

As with all other patient encounters, body substance isolation is of utmost importance when you are assessing and treating trauma patients. In accident settings, it is a good idea

to have an extra pair of gloves available in the event your gloves are compromised by glass, sharp metal, or other debris at an accident scene. In addition, accident events often involve multiple victims, which may require you to rapidly assess and triage more than one patient. To prevent exposing a patient to the bodily fluids of another, gloves should be changed before each encounter with a new patient.

Airway management of the patient in shock may range from providing supplemental oxygen via a nonrebreather mask for a patient who is not exhibiting signs of respiratory distress to endotracheal intubation for a patient who cannot effectively maintain a patent airway. All trauma patients who are exhibiting signs of shock should at a minimum receive supplemental oxygen by mask. Only competent patients who refuse oxygen by mask should be placed on a nasal cannula (BTLS, 2004).

Suctioning may be required for patients who are unable to clear their own secretions, or to remove blood, emesis, or foreign objects from the airway. Suctioning the airway prior to attempting intubation will improve intubation success if fluids or foreign objects are present. Even patients with minor to moderate oral or facial injuries who are alert and oriented may not be able to clear their airways effectively when placed supine with spinal immobilization. Continual re-assessment is required to ensure that the patient maintains an open airway throughout transport.

Some patients require mechanical assistance to maintain adequate ventilation and oxygenation. The oropharyngeal airway (OPA) and nasopharyngeal airway (NPA) are designed for use in patients with an altered level of consciousness to prevent the patient's tongue from falling to the back of the oropharynx and interfering with ventilation.

If a patent airway can not be maintained utilizing an OPA/NPA and a bag valve mask with supplemental oxygen, endotracheal intubation or use of a dual-lumen airway device may be required; however, if oxygenation and ventilation can be maintained with a OPA/NPA airway, rapid transport to an appropriate trauma facility should take precedence over extending scene time to secure an advanced airway in the field.

Control of external bleeding requires a variety of techniques, depending on the location and severity of the injury. The initial step to control bleeding involves direct pressure, performed by placing fingertip pressure directly on the site of the bleeding. Elevation of a bleeding extremity may be used secondary to and in conjunction with direct pressure if needed.
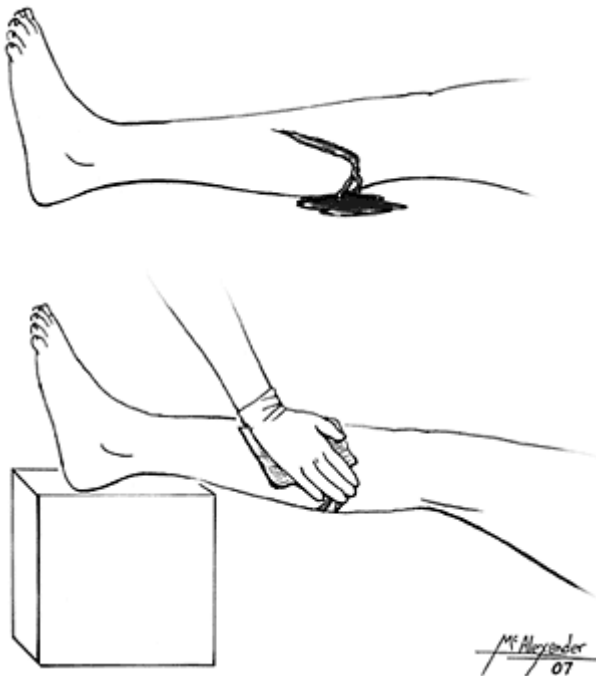
To intervene with a bleeding wound, apply sterile gauze and direct pressure and elevate the extremity if possible. (Illustration by Jason M. McAlexander, MFA. Copyright © 2007 Wild Iris Medical Education.)

Large gaping wounds may require packing with sterile gauze and direct hand pressure if direct fingertip pressure fails to control bleeding. If bleeding is still uncontrolled, or soaks through the dressings, additional pressure should be applied to the site. In the past, it was taught that if bleeding soaks through a dressing, additional dressings should be placed on top of the original dressing. However, ITLS now instructs caregivers to remove the soaked dressing and redress the wound once to ensure that pressure is being applied directly to the location of the bleeding (BTLS, 2004). In the upper and lower extremities, pressure points may also be used to control significant bleeding.

Elevation of the lower extremities by 8 to 12 inches may be effective in improving circulation to vital organs for a patient in shock; however, it should not be attempted if the patient has suspected injuries to the pelvis, lower extremities, head, chest, abdomen, neck, or spine—which accounts for the majority of traumatic injuries.

If signs of shock are present and the lower abdomen is tender, or pelvic injury is suspected, application of the pneumatic anti-shock garment (PASG) may be indicated if allowed by local protocol or medical direction. The PASG device cannot be used in patients with suspected chest injury because the device increases pressure in the chest, potentially worsening bleeding from chest injuries.

For patients exhibiting signs of shock, the goal is rapid transport with spinal precautions in place. Splinting of suspected fractures and dislocations may decrease the incidence of pain for the patient; however, if rapid transport is indicated, splinting of long-bone

fractures may be all that time allows. If the patient has a suspected or obvious femur fracture, use of a traction splint will decrease the incidence of pain and prevent free motion of the bone ends, which could lacerate the femoral artery or vein, thus increasing blood loss and worsening the progressing shock.

In order to complete a thorough primary assessment, exposure of all or most of the patient is critical to finding all injuries; however, patients should be covered with a blanket as quickly as possible to preserve the patient's privacy and to conserve body heat. In some cases, complete exposure can be delayed until the patient is in the back of a warm ambulance, prior to transport.

Keeping in mind that a patient can lose up to 2000 ml of fluid from a femur fracture, it is important to identify potentially significant trauma early in your assessment. The goal is to transport the patient expeditiously to an appropriate facility capable of surgical intervention. Direct pressure, splinting, and fluid replacement are only temporizing measures; trauma is a surgical disease.

# EMERGENCY MEDICAL CARE

## Chest Injury

Chest injuries fall into two general categories; open and closed. Appropriate management of closed chest injuries relies almost exclusively on a comprehensive evaluation of the mechanism of injury and on patient assessment. Closed chest injuries may be present with minimal or no outward signs immediately following the event. Patients may complain of chest pain that worsens on palpation, or of difficulty breathing.

Often chest trauma is associated with multi-system trauma, which may distract the patient from identifying symptoms related to an underlying chest injury. Closed chest injuries may include pulmonary or cardiac contusion, fractures of the sternum, scapulae, or ribs, pneumothorax, or hemothorax.

Following trauma, patients who present with difficulty breathing, unilateral diminished lung sounds, and hypotension may have an underlying tension pneumothorax, which requires immediate intervention. In some cases, tracheal deviation may be apparent: however this is a late sign and it is difficult to visualize on some patients. A simple pneumothorax that does not result in respiratory or vascular compromise does not necessitate prehospital treatment. Advanced life support treatment for tension pneumothorax is needle decompression of the affected side.

Up to 15% of all deaths following motor vehicle collisions are due to injury to the thoracic aorta. Many of these patients are dead at the scene from complete aortic transection. Patients who survive to the emergency department usually have small tears or partial-thickness tears of the aortic wall (PHTLS, 2003).

Most blunt aortic injuries occur in the proximal thoracic aorta, although any portion of the aorta is at risk. The proximal descending aorta, where the relatively mobile aortic arch can move against the fixed descending aorta, is at greatest risk from the shearing forces of sudden deceleration. Thus the aorta is at greatest risk in frontal or side impacts and falls from heights (Trauma.org, 2004).

Patients with blunt aortic injuries surviving to arrival at the hospital usually have partial transections, and should be managed with blood pressure control until surgical repair. The priority in the management of hemodynamically unstable patients with potential aortic injuries is to rapidly identify and control ongoing hemorrhage from other sites, and to avoid over-resuscitation. Overly aggressive fluid resuscitation can lead to complete aortic rupture for these patients by increasing intra-aortic pressure. Clinical signs of traumatic aortic injury are rarely present, and diagnosis is based on a high index of suspicion related to the mechanism of injury (Trauma.org, 2004).

Management of open chest wounds is dependent on the location and severity of the injury. Penetrating trauma to the chest should be managed with an occlusive dressing, such as a petroleum jelly (Vaseline) or bi-occlusive dressing. Upon initial identification, a gloved hand should be used to occlude the injury site while further assessment takes place to identify other life-threatening injuries. Once an occlusive dressing has been placed, the patient should be frequently re-evaluated for signs of a developing tension pneumothorax. If signs or symptoms of a tension pneumothorax develop, lift an edge of the occlusive dressing to allow trapped air to escape.

All patients with obvious or suspected chest injuries should receive supplemental oxygen at an appropriate flow rate, and be placed in a position of comfort if spinal injuries are not suspected.

# Abdominal Injuries

Depending upon the underlying structures affected, abdominal injuries can result in significant hemorrhage. Most of the abdominal organs—including the liver, spleen, stomach, pancreas and the reproductive organs—are located in the peritoneal cavity. The **peritoneum** is a smooth transparent membrane that lines the abdomen and doubles back over the surfaces of the internal organs to form a continuous sac. Some organs and major vessels such as the kidneys, inferior vena cava, and aorta, are located posterior to the peritoneum in what is referred to as the retroperitoneal space. The primary function of the peritoneum is to protect the internal organs from injury.
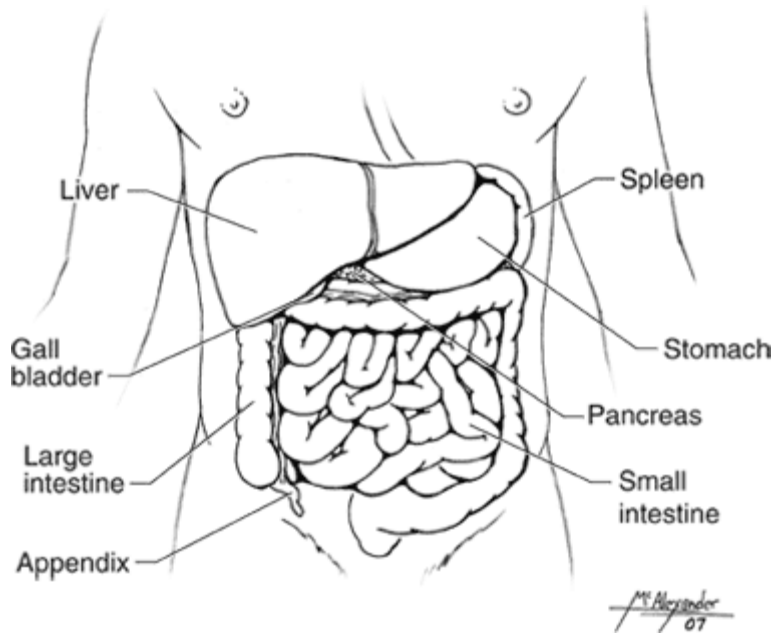
The abdominal organs. Think about what organs might be injured from seatbelt placement.

Improperly positioned seatbelts can cause liver or spleen ruptures that may result in significant internal blood loss. In blunt abdominal trauma, the most commonly injured organs are the spleen and the liver. The liver is frequently injured in penetrating trauma due to its relatively large size. The liver is a very vascular organ and bleeds profusely when it is injured (Health Care Information, 2006). A patient who has experienced a traumatic injury and who presents with signs of shock having no apparent cause should be considered to have abdominal bleeding until proven otherwise.

Appropriate treatment for a suspected closed abdominal injury is dictated by the patient's presentation. Patients exhibiting clinical signs of hypoperfusion such as an altered mental status and cool, pale skin should be transported expeditiously to an appropriate trauma receiving facility. Supplemental oxygen is administered to all patients exhibiting signs or symptoms related to a traumatic event. Advanced life support treatment includes initiating IV access and titrating fluids to maintain adequate perfusion as evidenced by a systolic blood pressure of 90 to 100 mm Hg (BTLS, 2004).

Treatment for an open abdominal injury focuses on reducing the risk of infection by protecting the exposed tissue and organs. Exposed organs should not be touched, and you should make no effort to replace organs that are protruding out of the abdominal cavity. Replacing organs that have been exposed to environmental contaminants may result is severe infection and complications in the patient's long-term recovery.

Open wounds and organs that are exposed should be covered with a sterile dressing, moistened with saline or sterile water, and secured in place. If you do not suspect lower-extremity injuries, placing the patient in a position that allows flexion of the hips and

knees will accommodate relaxation of the abdominal muscles and possibly decrease patient discomfort.

# Amputations

Traumatic amputations are a dramatic finding at the scene. The mechanism of injury that results in an amputation can frequently produce other significant injuries as well; however, it is easy to become distracted by the amputation. Initial management of traumatic amputations includes a complete primary assessment of the patient to rule out other life-threatening injuries including potential hemorrhage from the amputation site.

If a patient has sustained a partial amputation, the area should be immobilized and dressed to prevent further injury. In rare circumstances, partial amputations have required that the amputation be completed in order to free an entrapped patient; however, generally no attempt is made to complete a partial amputation.

Once initial stabilization has been addressed, efforts are made to preserve the integrity of the amputated part. The part should be wrapped in a sterile dressing moistened slightly with saline or sterile water, and then placed in a plastic bag and kept cool. To avoid tissue damage, an amputated part should never be placed directly on ice or in contact with a chemical cold pack.

In the chaos of a scene that may include multiple patients and multiple ambulances, or the utilization of helicopters to facilitate transport to trauma centers, be careful to ensure that the amputated part is transported with the patient.

# Burns

While the leading cause of fatal fires is related to smoking materials such as cigarettes, the majority of residential fires that result in burn injuries are caused by cooking equipment (Stanford, 2006). Though the majority of deaths caused by fire are related to smoke inhalation, many severely burned patients survive the fire but later succumb to infection.

Burns are commonly categorized as first-, second-, or third-degree, which are sometimes known as superficial, partial-thickness, or full-thickness, respectively. Superficial burns are painful burns that are characterized by inflamed red skin. Though field treatment of superficial and partial-thickness burns is directed at controlling pain, the first priority for all burns is ensuring that the burning process has stopped.
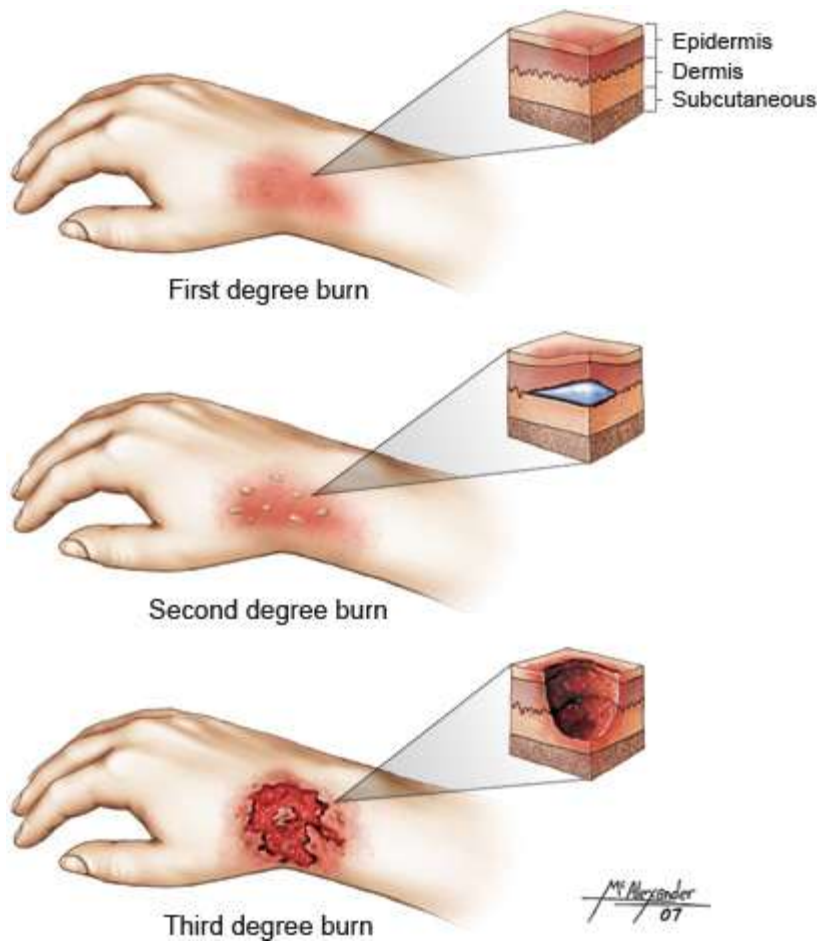
First-degree burn reddens the epidermis; (2) second-degree burn penetrates the epidermis and causes blistering; (3) third-degree burn penetrates the dermis and requires careful attention to heal successfully. (Illustration by Jason M. McAlexander, MFA. Copyright © 2007 Wild Iris Medical Education.)

After observing Universal Precautions, any jewelry or clothing that may be retaining heat should be removed, followed by a water or saline flush for most burns. Burns caused by dry lime, soda ash, phenol, lithium, and sodium metal should not be flushed with water or saline. Local poison control or CHEMTREC should be contacted for direction on appropriate management of these patients (PHTLS, 2003).

Once the burning has been controlled, the area should be covered to avoid further contamination. Burns should only be covered by dry sterile dressings. Moist burn sheets, ointments, lotions, or antiseptics should never be used prehospital. Use of moist dressings for large burns can result in hypothermia. Pain should be managed by the use of analgesics when allowed by protocol. Avoid breaking open blisters, as this increases the risk of infection. Most local protocols allow for burn patients who do not have acute airway compromise to be transported to specialty facilities capable of managing these patients.

Burn patients should be continually reevaluated for airway compromise. Painful burns may distract a patient from recognizing symptoms of advancing airway edema. Stridor, coughing, singed facial hair, and soot around the mouth or nares may indicate potential airway involvement. All patients who have experienced thermal burns should receive supplemental oxygen to treat possible hypoxia related to inhalation and compromised circulation.

# INJURIES TO BONES AND JOINTS

## Signs and Symptoms

Bone and joint injuries are rarely fatal; however, they are usually quite painful. Signs and symptoms associated with bone and joint injuries may include:

- Deformity or angulation
- Pain and tenderness
- Grating
- Swelling
- Bruising
- Exposed bone ends
- Joint locked into position

Fractures are categorized as open (compound) or closed (simple). A **compound fracture** is the result of an underlying fractured bone or bones breaking through the surface of the skin. The bones may protrude through the skin and remain out, or they may break the skin surface and then retract beneath the skin. Any open injury associated with a possible fracture should be treated as a compound fracture, regardless of whether bone is visible.

When in doubt about the existence of a fracture, a painful extremity injury should be splinted even if none of the above signs and symptoms is present. The presence of pain is indicative of injury, and splinting may serve to decrease the patient's discomfort.

## Emergency Care of Bone or Joint Injuries

When assessing a patient with a suspected fracture, it is important to obtain a good history in order to determine the mechanism of injury, and the potential for other injuries in addition to the painful fracture.

As an EMS professional, one of the most important things to keep in mind when you are assessing a trauma patient who has an extremity fracture is that the pain associated with the fracture may distract the patient from recognizing injuries in other areas. In the presence of a painful extremity fracture, the patient may not clearly identify cervical spine pain on palpation. For this reason, you need to consider spinal immobilization for

patients who have experienced a high-risk mechanism of injury resulting in isolated extremity trauma even if the patient does not complain of neck or back pain.

After following Universal Precautions, assess the patient for life-threatening injuries. In the absence of life-threatening injuries, splint fractures prior to transport to control pain and prevent further injury. For the critical patient, splinting should be accomplished as time allows once transport has been initiated.

Supplemental oxygen is considered and applied as indicated by the patient's presentation. Elevation and the application of a cold pack to a painful, swollen, or deformed extremity will reduce both pain and swelling to the area. Keep in mind that cold packs should be applied only following a dressing so that the cold pack does not come in direct contact with the injury site.

## General Rules of Splinting

Before splinting, remove clothing or cut it away and assess the extremity for pulse, movement, and sensation distal to the injury site. The proximal and distal joint should be immobilized for a suspected bone injury, and the proximal and distal bone should be immobilized for a suspected joint injury. Following splinting, re-assess pulse, movement, and sensation and record both assessments on the patient care report.

Open fractures are managed by applying a sterile dressing and splinting the extremity in a position of comfort. Dressings moistened with sterile water may improve healing if transport time is prolonged. To reduce the risk of infection and further tissue damage, protruding bones should not be pushed back under the skin. If during the application of a traction splint the bone ends retract beneath the surface, do not increase the amount of traction. Take care when placing the splint to ensure that it is well padded and does not put pressure on the protruding bone (BTLS, 2004).

Closed fractures may be less dramatic in their presentation but associated hemorrhage can be difficult to determine. Bilateral closed femur fractures can result in a blood loss of up to 2 liters, and pelvic fractures can result in life-threatening hemorrhage with significant bleeding into the abdominal cavity before symptoms become apparent. As with open fractures, closed fractures are splinted in a position of comfort.

Ensuring that the splint is well padded will reduce discomfort to the patient. Pain control with analgesics should be considered for patients with isolated extremity fractures but may be contraindicated in the presence of multi-system trauma. Analgesics can complicate the physician's assessment in the emergency room, making it difficult to ascertain the location of the patient's injuries.

If a fractured extremity is angulated and pulses are absent, you may apply gentle traction in an attempt to restore circulation; however, excessive manipulation can result in further damage to underlying structures. If a receiving facility is close, expeditious transport may be the most appropriate treatment.

# SPINAL INJURIES

## Mechanism of Injury with High Index of Suspicion

In 2006 the Spinal Cord Injury Information Network estimated that annual incidence of spinal cord injury, not including those who die at the scene of the accident, is approximately 40 cases per million population in the United States, or approximately 11,000 new cases each year (SPIIN, 2006).

Spinal cord injury primarily affects young adults, with most injuries occurring between the ages of 16 and 30. However, the number of injured adults over 60 years of age has steadily increased from 4.7% prior to 1980 to 11.5% since 2000. About 78% of spinal cord injuries occur in males (SPIIN, 2006).

Motor vehicle crashes account for 46.9% of reported spinal cord injuries cases. The next most common cause of these injuries is falls, followed by acts of violence (primarily gunshot wounds). Recreational sporting activities also account for a number of spinal cord injury cases annually (SPIIN, 2006).

## Signs and Symptoms of Spine Injuries

Patients not exhibiting an altered level of consciousness and those without a distracting injury or neurologic deficit may exhibit tenderness or pain on palpation or with movement. Never move patients or ask them to move or perform range of motion (ROM) exercises to elicit a pain response. Pain that is independent of movement or palpation may manifest not only in the spinal column but also in the legs if there is swelling or injury to nerves along the spinal column. Pain may also be caused by muscle contractions that can be intermittent in nature.

Obvious deformity to the spine may be noted on palpation. Depending on the degree of deformity, this may present an issue when placing the patient supine on a long spine board. This issue can usually be overcome by padding the board to accommodate the deformity.

Signs of neurologic injury may include:

- Numbness, weakness, or tingling in the extremities
- Paralysis in one or more extremities, or below the level of injury
- Loss of sensation to one or more extremities, or below the level of injury
- Incontinence
- Priapism

Regions of the body affected by spinal injuries
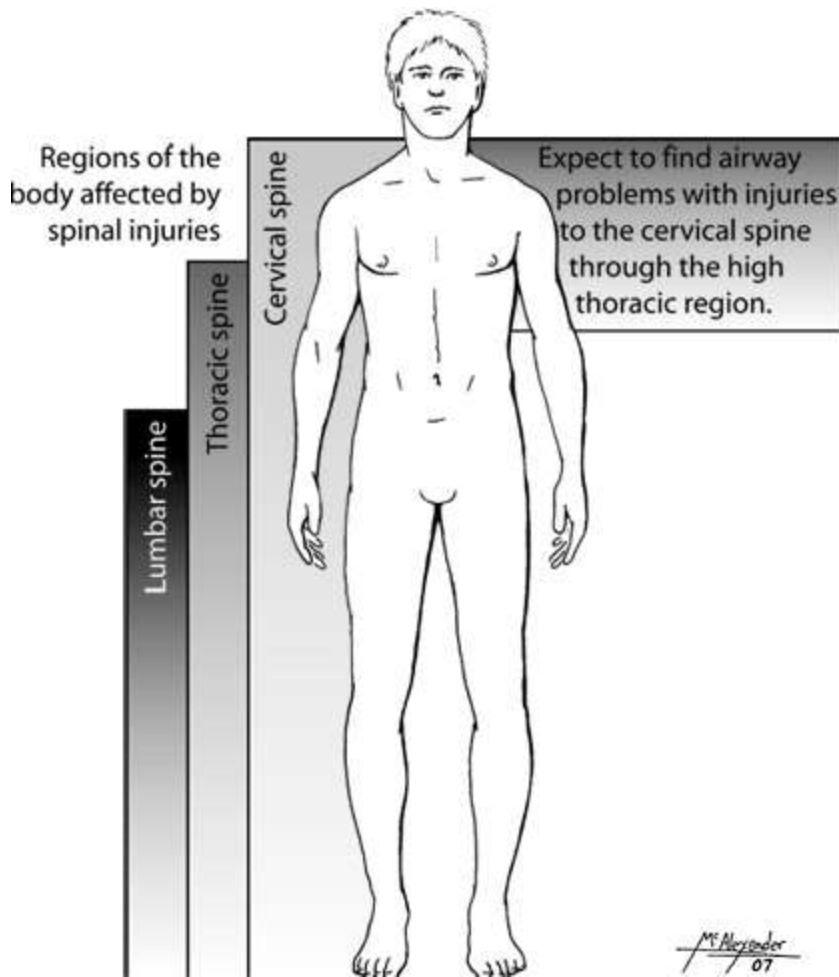
Injuries to the spinal cord resulting in paralysis or loss of sensation may be related to a number of specific injury types. **Cord contusion** involves bruising or bleeding into the tissues or the spinal cord, and may result in a temporary loss of function below the level of the injury. **Cord compression** results from pressure on the spinal cord that is causing swelling, which can result in tissue ischemia. A **cord laceration** describes cord tissue that is torn or cut. Both compression and laceration can result in either permanent or transient disability. Complete **cord transection** interrupts all cord function distal to the injury site, resulting in permanent disability (PHTLS, 2003).

Though injury to nerves that control the bladder may result in urinary incontinence, incontinence in the presence of trauma may also be caused by a traumatic brain injury.

In male patients, spinal injuries may result in priapism. **Priapism** is a prolonged erection of the penis resulting from unopposed parasympathetic stimulation caused by an insult to the spinal cord (Mistovich et al., 2003).

# Assessing the Potentially Spine-Injured Patient

For responsive patients, you attain a history of the event from both the patient and any bystanders. When asking "What happened?" you may find the bystander's account of the incident differs from the patient's recollection of the event. This suggests that the patient had an associated loss of consciousness that may be denied upon questioning.

The patient should be asked if there is any pain in the neck or back. If the patient indicates that there is tenderness or pain, palpate the area to localize the site and to determine if there is any associated deformity. To avoid unnecessary movement of the spine, do not ask the patient to point to the area of injury.

To check for appropriate neurologic response, ask patients to move their hands and feet, and palpate their fingers and toes while asking if they can feel your touch. Assess the extremities for equality of strength by asking the patient to grip your hands, and gently push their patient's feet against your hands. The neurologic assessment should be performed both before and after placing the patient in spinal immobilization, and intermittently throughout transport, with all findings chronologically documented on the patient care report.

In the trauma setting, all unresponsive patients and all patients who demonstrate an altered level of consciousness should be considered to have a spinal injury. In attempting to transport an unresponsive trauma patient quickly to a trauma center, spinal precautions are often overlooked. Though expeditious transport is very important to these patients, preventing further injury to the spine is an important consideration in the patient's long-term quality of life following the accident.

When assessing an unresponsive patient, your determining the mechanism of injury is important to the receiving physician. When a patient is unable to provide an account of the event, the only other clues as to what occurred are at the scene They include:

- Bystander accounts of the incident
- The patient's mental status preceding the event
- Damage to vehicles
- Height of potential falls

After managing any life-threatening injuries, make a quick survey to reveal any contusions, deformities, lacerations, punctures, penetrations, or swelling.

Patients are transported after being secured to a padded long spine board, with appropriate cervical immobilization. As with any other trauma patient, supplemental oxygen is administered, titrated appropriately.

## Emergency Medical Care

As with all other trauma patients, patients with suspected spinal injuries should be treated for life-threatening injuries before managing the spinal injury; however, every effort should be made to limit movement to the spine while performing these treatments. Manual in-line immobilization is maintained while advanced airway procedures are performed and bleeding is controlled.

Patients with a spinal injury are immobilized in a supine position on a rigid spine board in a neutral in-line position. The head, neck, torso, and pelvis must each be immobilized to prevent further movement (PHTLS, 2003).

Place an appropriately sized cervical collar to immobilize the cervical spine. Cervical collars do not adequately immobilize the cervical spine unless the patient is motion-restricted on a spine board with head blocks in place.

Spine boards should be padded to provide comfort to the patient, and to minimize the risk of soft-tissue injuries to the patient's skin. Additional padding may be needed under the patient's shoulders to accommodate patients immobilized with a helmet, or for pediatric patients whose heads are anatomically disproportionate to their body size.

Supplemental oxygen is provided to the patient, and the patient is transported to an appropriate receiving facility.

# HEAD INJURIES

## Mechanism of Injury with a High Index of Suspicion

Approximately 1.4 million people suffer traumatic brain injuries (TBI) annually in the United States, which results in 50,000 deaths and 235,000 hospitalizations. Of these injuries, 28% are caused by falls, 20% are the result of motor vehicle accidents, and 11% are the result of an assault (CDC, 2006).

The CDC estimates that at least 5.3 million Americans, approximately 2% of the U.S. population, currently have a long-term or lifelong need for help to perform activities of daily living (ADLs) as a result of a TBI.

Traumatic brain injuries can cause a wide range of functional changes that affect thinking, sensation, language, and emotions. They can also cause epilepsy and increase the risk for conditions such as Alzheimer's disease, Parkinson's disease, and other brain disorders that become more prevalent with age (CDC, 2006).

When evaluating the scene of a motor vehicle accident, inspect the windshield for blood, hair, starring, or deformity. If your patient was involved in an accident while wearing a

helmet, inspect the helmet for scratches, dents or breaks, as well as for the presence of blood or brain matter. It is important to note and report to the receiving facility the extent of damage as well as the type of helmet worn.

There are essentially three types of helmets—full-face, three-quarter shell, and half-shell—that offer varying degrees of protection. Evaluating the type of helmet worn may help in determining the extent of possible injuries to both the face and head.

## Signs and Symptoms of Head Injury

Skull injuries may present with contusions, lacerations, or hematomas to the scalp; blood or fluid leakage from the ears or nose; and/or bruising around the eyes or behind the ears. Deformity to the head may also indicate the presence of a skull injury; however, 80% of all skull fractures are linear, not depressed (PHTLS, 2003).



Head trauma. Note periorbital ecchymosis (raccoon eyes), enlargement of one pupil, fluid from the ear, and bruising behind ear (Battle's sign).

Fluid leakage from the nose or ears can be a relatively early indication of a basilar skull fracture, while bruising around the eyes (referred to as raccoon eyes) is a dramatic sign that usually develops later. Another late sign, which may be evidence of an occipital basilar skull fracture, is bruising behind the ears, known as Battle's sign. Both of these signs generally develop within hours of the injury.

Though skull fractures may make for a dramatic presentation, the underlying injury to the brain, and the symptoms associated with that injury, dictate the appropriate management of the patient.

Head injuries are categorized as open or closed. Both may produce an altered or decreasing mental status demonstrated as confusion, disorientation, repetitive questioning, or unresponsiveness. Other signs may include neurologic disability, nausea and/or vomiting, seizures, or unequal pupils. Changes to the patient's breathing may also be present depending on the location of the injury and the degree of intracranial pressure.

Though drugs, alcohol, and other altered physiology may result in unusual presentation of the pupils, these findings, when associated with an altered mental status, may also indicate the severity and location of a traumatic brain injury. In this setting, dilated nonreactive pupils indicate a brain stem injury with a grim prognosis; however, if the pupils are dilated but reactive, the injury may be reversible. Unequal pupils (**anisocoria**) with one dilated but reactive pupil are a sign of increasing cerebral pressure, and anisocoria with a dilated, nonreactive pupil is an extreme emergency mandating rapid transport and hyperventilation (BTLS, 2004).

# Emergency Medical Care

After taking Universal Precautions, the first step in management of the head-injured patient is addressing any life-threatening conditions that may be present. After those conditions have been addressed, the focus moves to managing cerebral perfusion by maintaining adequate oxygenation of cerebral tissues and maintaining the patient's blood pressure (PHTLS, 2003).

An initial assessment with spinal immobilization is done on scene, with a complete detailed physical exam performed en route. Prehospital care for head-injured patients is directed at preventing further injury or insult and delivering the patient to a higher level of care for definitive treatment. Quick transport to an appropriate receiving facility is a high priority.

Because altered patients may not be able to effectively maintain an open airway, airway management is a priority for these patients. Supplemental oxygen is indicated for the patient's hypoperfused cells. Some patients will require endotracheal intubation; however, keep in mind that multiple attempts at intubation have been shown to increase intracranial pressure (ICP).

Advanced airway management for head-injured patients should be performed by the most experienced provider on scene. If a head-injured patient requires intubation, cervical spinal precautions must be maintained throughout the procedure. Use of alternative airway devices, such as the Combitube, King Laryngeal Tube, or EOA may be considered, and may minimize manipulation of the cervical spine.

Open head injuries often bleed profusely. Usually the bleeding is from scalp injuries rather than within the cranium. Bleeding is controlled with direct pressure and pressure dressings; however, pressure should not be applied to an open or depressed skull injury. Any impaled object is bandaged in place to minimize manipulation.

An open head injury may present with the presence of brain matter. The presence of brain matter outside of the cranial vault is not in and of itself an indication of death. A patient who is still breathing, and has a pulse, should be treated and transported in the same manner as any other head-injured patient and treated in accordance with the assessment findings.

Head-injured patients need to be frequently reassessed. As ICP increases, changes to the patient's vital signs may indicate a need to adjust your treatment plan. If a patient who was initially confused becomes unresponsive, you may consider intubation. If changes to the pupils are noted, as discussed in the previous section, it may be appropriate to adjust the ventilation rate you are delivering.

Assume that any patient with a head injury has an associated spinal injury. Spinal precautions should be taken to reduce the risk of further exacerbating unidentified spinal injuries.

# RAPID EXTRICATION

## Indications

Patients who are in immediate danger of death may require emergency rescue from a vehicle or structure. Dangerous scenes such as those that involve active fire, rising waters, or imminent risk of explosion or structure collapse may require the rescuer to move a patient to safety emergently.

Patients who are unstable on initial assessment may also require rapid extrication. For example, a patient involved in a motor vehicle collision who is hemorrhaging from a traumatic injury may need to be rapidly extricated in order to manage the wound effectively and prevent exsanguination (bleeding out).

Another situation in which rapid extrication may be warranted is when one patient is blocking access to another seriously injured patient, requiring that the first patient be moved to provide care to the second patient.

Rapid extrication should only be performed if there is an immediate risk of death or serious injury to the patient or rescuer, and the reason for rapid extrication should be well documented on the patient care report. Since the focus of rapid extrication is on moving quickly, usually delaying full immobilization of the spine until the patient is removed from the scene, it should only be performed in truly urgent cases.

# Procedure

Multiple rescuers should be used to perform rapid extrication so that the risk of injury to the patient is reduced as much as possible. Keep in mind that even though this is a rapid extrication **every effort must be made to limit movement of the spine**.

To perform the extrication, one rescuer gets behind the patient and brings the cervical spine into neutral in-line position while providing manual stabilization. A second rescuer applies a cervical immobilization device as a third rescuer places a rigid spine board as near the patient as possible. Working along the long axis of the patient, one rescuer continues to hold and stabilize the head while a second rescuer supports the thorax and a third rescuer frees the lower extremities from any obstacles. With the first and second rescuers coordinating their movements to limit rotation of the spine, the patient is maneuvered onto the spine board in short controlled movements.

As the patient is removed from the vehicle or structure, an external rescuer or bystander should assume control of the patient's head and cervical spine as the patient is extricated. If possible, a gurney should be as close as possible so that the board can be placed on the gurney immediately when it is freed from the wreckage.

It may be necessary to move the patient to a safer location before fully securing the patient to the board. This is accomplished more safely with the patient on the gurney rather than being carried on the board. Once the rescuers and patient are no longer in danger, the patient should be appropriately secured to the spine board and cervical immobilization with a collar and head blocks completed as usual.