



Seattle-King County EMS

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CBT/OTEP 445 Head, Spine and Chest Trauma

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Introduction

The head, spine and chest contain the body's most vital organs. Although they are well-protected, blunt or penetrating trauma can cause life threatening injuries when any of these areas are insulted.

Your job when dealing with trauma is to determine if a patient is SICK or NOT SICK, assess the extent of the injuries and stabilize the patient so that no further injury occurs prior to arrival at a hospital.

Before You Begin

This is a continuing education and recertification course for EMTs. It covers fundamental EMT-Basic concepts and terminology as well as advanced material. We highly recommend completing the case studies and practice exam before completing the exam.

We also recommend that you review EMT textbook chapters covering Orthopedic Emergencies as a refresher before taking the exam, for example: Chest Injuries (Chapter 27) and Head and Spine Injuries (Chapter 30) in *Emergency Care and Transportation of the Sick and Injured*, 9th edition (AAOS).

Practical Skills

To receive CBT or OTEP credit for this course a trained skills evaluator must evaluate your ability to perform the following hands-on practical skills including:

- rapid trauma exam
- backboard
- control of major bleeding
- jaw thrust
- lifting and stretcher skills

Objectives

CBT445 is an EMT continuing education and recertification course. After completing this course you will be able to:

1. Recognize the key anatomic structures of the head, spine and nervous system.
2. Identify cases of potential head injury given signs and symptoms.
3. Recognize the steps for emergency care of a head injury.
4. Recognize the types of forces that can cause injuries to the spine.
5. Identify cases where there is a potential for spine injury.
6. Identify situations in which spinal immobilization is unnecessary.
7. Recognize the steps for emergency care of a spine injury.
8. Recognize signs and symptoms of a chest injury.
9. Recognize the steps for emergency care of a chest injury.

Terms

Terms You Should Know

central nervous system (CNS) — The main part of the nervous system that includes the cerebrum, cerebellum, brain stem and spinal cord.

cerebrospinal fluid (CSF) — Clear fluid that surrounds and protects the brain and spinal cord. It provides a cushion from blows to the head.

ecchymosis — The purple or black-and-blue area resulting from a bruise.

neutral, in-line position — A position where a patient's spine is not flexed, extended or rotated.

peripheral nervous system (PNS) — A division of the nervous system that includes nerves running from the spinal cord to the body's organs, skin and muscles.

pneumothorax — A condition where there is air in the pleural space.

tension pneumothorax — A progressively worsening pneumothorax that begins to impinge on the function of the lungs and the circulatory system.

traumatic asphyxia — Occurs when the pressure of a sudden compression of the chest or abdomen forces blood out of the right side of the heart and into the veins of the neck.

New Terms

arachnoid — A delicate membrane that encloses the spinal cord and brain and lies between the pia mater and dura mater.

brain herniation — A condition in which part of the brain is squeezed through an opening in the skull.

cardiac tamponade — The accumulation of fluid in the pericardial space which reduces ventricular filling and causes shock.

cerebral edema — Swelling of the brain.

dura mater — The tough fibrous membrane covering the brain and the spinal cord and lining the inner surface of the skull. It is the outermost of the three meninges that surround the brain and spinal cord.

meninges — The membranes that cover the brain and spinal cord: the dura mater, the arachnoid mater and the pia mater.

parasthesia — A pins and needles sensation in the arms or legs.

paresis — Weakness

petechiae — Small red or purple spots on the skin, caused by broken capillary blood vessels.

pia mater — The fine vascular membrane that closely envelops the brain and spinal cord under the arachnoid and the dura mater.

Brain Structures

The anatomy of the brain is such that different body functions are controlled by three different structures: the cerebrum, cerebellum and brain stem. These structures control many body activities including sleep, emotions, muscle movement, hunger and memory.

Layers of the Defense

The skull is the outmost layer of defense that protects the brain. It is very durable. Nevertheless, if a force is great enough, the skull can be cracked just like a coconut shell.

The meninges is a thin membrane that surrounds both the brain and spinal cord. The meninges contain three distinct layers: the dura mater, the arachnoid and the pia mater.

The space between the pia mater and the arachnoid space is filled with cerebrospinal fluid (CSF).

Elaboration – Meninges

The brain and spinal cord are protected by several membranes called the meninges. The meninges surround both the brain and spinal cord and contain three layers:

- Dura mater
- Arachnoid
- Pia mater

The dura mater is the outermost layer of the meninges. This thin, rubber-like layer is attached to the inner surfaces of the cranium and spinal column.

The middle layer is called the arachnoid.

The pia mater covers the surface of the brain and spinal cord. The space between the pia mater and the arachnoid is filled with cerebrospinal fluid.

Elaboration – Cerebrospinal Fluid

Cerebrospinal fluid (CSF) surrounds the brain and spinal cord and acts like a shock absorber. It is confined within the layers of the meninges. When the skull is fractured the meninges can be damaged and CSF can drain from the nose or ears.

Spine

Thirty-two bony vertebrae form the spinal column and protect the spinal cord. Individual vertebra are separated by shock-absorbing discs. Tendons, ligaments and muscles secure and protect the spinal column.

Spinal Cord

The spinal cord is made of nerve tissue and is surrounded by cerebrospinal fluid. The cord has 31 segments each giving rise to a pair of spinal nerves that leave the cord from openings between each vertebra.

Elaboration – No Room to Expand

The spinal cord occupies 95% of the space in the spinal canal which leaves little room for expansion. In addition, slight movements that displace structures in the spinal column can easily damage the spinal cord.

The Nervous System

The spinal cord carries messages from the brain to the rest of the body. Together the brain and the spinal cord make up the central nervous system that helps control all body systems and organs.

The peripheral nervous system is made up of all the nerves that project out of the brain and spinal cord.

Nerves that extend from the spinal cord and control the muscles of the body are called *motor nerves*. Nerves that travel back to the brain and spinal cord and detect sensations of feeling, hot or cold and position are called *sensory nerves*.

Elaboration - Voluntary and Autonomic Nervous Systems

The nervous system also may be divided by function. The *voluntary nervous system* influences activity of the skeletal muscles. These are muscles controlled by conscious thought, for example, the biceps.

The *autonomic nervous system* is the part of the nervous system that influences the activities of involuntary muscles and glands, for example, the heart.

Chest

The chest contains the heart, lungs and great vessels. These vital structures are protected by the ribs, sternum, scapulae, clavicles and the spine.

Scalp Laceration

Lacerations to the face and scalp account for approximately half of the wounds treated in emergency departments. Because the head has such a rich supply of blood, scalp lacerations can bleed profusely.

Concussion

A concussion usually is caused by a blow to the head or face. When a boxer is knocked out by a punch, he is actually experiencing a concussion.

A concussion involves a temporary loss of consciousness with return of full brain activity. There is no permanent damage though there may be symptoms of dizziness or headache for several days following the trauma.

Contusion

A contusion of the brain is a bruise like any other bruised tissue. However, it can affect in mental function and cause weakness, poor coordination, aphasia, memory loss and cognitive problems.

Skull Fracture

A skull fracture is a fracture or break in any of the cranial bones. It takes a significant force to fracture the skull and, as a result, underlying injuries to the brain are common with skull fractures.

Head Bleed

Bleeding from a ruptured or lacerated blood vessel inside the skull leads to intracranial bleeding or bleeding within the head. If the bleeding is substantial and occurs rapidly, it can damage brain tissue and lead to a rapid deterioration of the patient's condition.

The damage primarily is caused by increased pressure inside the skull that compresses the brain.

Whenever a patient starts deteriorating following a closed head injury, you should suspect brain swelling (cerebral edema).

Elaboration - Intracerebral, Subdural and Epidural Hematoma

Depending on the location, bleeding can be within the brain (intracerebral), outside the brain but beneath the dura mater (subdural) or on top of the dura mater but beneath the skull (epidural).

Elaboration - The Elderly and Head Injuries

There are several things to consider when assessing an elderly patient with trauma to the head. First, the brain shrinks with age making it more susceptible to acceleration or deceleration injuries. Also, the veins inside the head are weaker and more easily torn. Finally, older patients often take blood thinners such as warfarin (Coumadin) or aspirin that increase the risk of a head bleed.

In the elderly, you must carefully evaluate the mechanism of injury because signs of internal bleeding may not be evident. Remember that a minor fall can cause a head bleed in an elderly person.

Cerebral Edema

A complication of a head injury is cerebral edema or swelling of the brain. Early signs of cerebral edema are difficult to detect although one early sign is unconsciousness. Late signs of cerebral edema and increased intracranial pressure (ICP) include:

- Irrational or combative behavior
- Changing level of consciousness
- Abnormal respiratory pattern
- Unequal pupils
- Posturing

Elaboration – Cerebral Edema, Increasing ICP and Brain Herniation

When the brain is injured (for example, from a blow to the head) it can swell in size. Since the skull is a closed space there is no room for expansion. This increases pressure on the brain.

If the pressure inside the skull becomes great enough, it can push against the exit hole at the base of the skull (foramen magnum) leading to involuntary flexion or extension of the arms and legs called decorticate or decerebrate posturing.

It can also cause changes in pupil size and respiratory rate and pattern. A dilated pupil following head trauma is a very poor sign and suggests that brain is under great pressure and trying to squeeze out the exit hole (herniation).

Level of Consciousness

A change in level of consciousness (LOC) is the single most important observation you can make in assessing the severity of brain injury. If you suspect a head injury, record a baseline assessment using the AVPU scale and record the time.

Consider these questions when assessing LOC and determining if there are neurological deficits:

- Does patient think and speak clearly?
- Does patient understand you completely?
- Can patient move all his or her limbs?
- Does patient have normal sensations when you touch skin?
- (Most important) Is patient's neurological status stable or deteriorating?

Assess neurological status once every five minutes.

Elaboration - AVPU

AVPU is a method for documenting LOC that places a patient in one of four categories:

A	Alert, responds normally
V	Verbal, responds to verbal commands
P	Pain, responds to pain
U	Unconscious, unresponsive

Pupil Response

The pupils are important assessment tools because the nerves that control their dilation and constriction are very sensitive to pressure within the skull.

When you beam a penlight into the eye, the pupil should constrict. An early and important sign of increased intracranial pressure is when a pupil does not constrict.

Unequal pupil size can be an indication of increased pressure on one side of the brain. It is interesting to note that the dilated pupil will be on the same side of the brain as the injury.

Head Injury and Hypovolemic Shock

An increase in intracranial pressure can cause a slow pulse and, if severe enough, a rising blood pressure. Note that an isolated head injury should not result in signs of hypovolemic shock. Shock due to blood loss generally results in a fast pulse and, if severe enough, a falling blood pressure.

If a head-injured patient shows signs of hypovolemic shock, assess for other internal injuries.

Emergency Care for a Head Injury

The best way to manage a scalp laceration is to apply direct pressure, even when bleeding is arterial and spurting. Use light pressure if there is a chance that the skull is fractured.

Emergency care for a potential internal head injury requires these steps:

- Protect the airway
- Provide oxygen and ventilatory assistance, if needed
- Maintain neutral in-line, cervical stabilization and stabilize spine
- Closely monitor vital signs and neurologic status
- Control bleeding

Elaboration – Ventilation and Increasing ICP

Adequate ventilation and high flow oxygen are beneficial to the head-injured patient. If you see late signs of increasing intracranial pressure and herniation, increase the ventilation rate with a bag-valve mask to 18-20 breaths/min.

Forces That Can Injure the Spine

There are numerous forces that can cause injury to the spine. These include:

- Compression
- Flexion
- Extension
- Rotation

- Lateral
- Distraction
- Penetration

Elaboration – Forces on the Spine

Compression forces can injure the spine when a person falls and lands on his or her feet, head or coccyx. Motor vehicle crashes can overextend, flex or rotate the spine.

These unnatural motions can result in fractures or neurological deficits. Any time the spine is distracted, or pulled along its length, you can expect to find serious injuries. For example, a hanging typically fractures the vertebrae high in the cervical spine.

Mechanism of Injury

Since most spine injuries are not apparent through observation, mechanism of injury (MOI) is an important factor in assessing the potential for a spine injury.

Look for evidence that a significant force was delivered to the body. Examples of evidence include: damage to vehicles, altered LOC, testimony by witnesses and signs of injury such as hematomas and bruises.

Symptoms of Spine Injury

The major symptoms you will see in a serious spine injury are weakness, numbness, tingling or paralysis in the extremities. Pain along the spine is another indication.

Absence of these symptoms does not rule out a spine injury. You must consider the mechanism of injury. Also, maintain a high index of suspicion in a trauma patient who is under the influence of drugs or alcohol or who has an altered LOC.

Elaboration – Feeling No Pain

Trauma patients frequently sustain a variety of painful injuries and may not complain of spinal pain. Be aware of the fact that spine-injured patients may be unreliable historians due to head injury or intoxication from alcohol or drugs.

Elaboration – Document Well

Document your findings in the narrative section of your patient care record. Good patient care and thorough documentation, including a description of your observations and the measures taken, are essential for continuing care and protecting you from liability.

Other healthcare providers who treat the patient will use your documented observations to evaluate whether or not the patient's condition is stable or worsening.

ABCs and Airway

Assessment and treatment of the ABC's is your highest priority in all patients with a suspected spine injury. Proper immobilization of a spine injury can consume your attention and energy. Do not lose sight of your main goal of providing basic life support by neglecting the patient's airway, breathing and circulation.

When you suspect a spine injury, use the jaw thrust maneuver to open the airway. Always remember:

The airway takes priority over other procedures including spinal immobilization.

Emergency Care for Spine Injury

Once you have determined that a significant MOI exists, begin neutral, in-line cervical spine stabilization. Apply a properly-sized cervical collar and maintain stabilization until the patient is fully immobilized on a backboard.

You may need to:

- Open airway using jaw thrust
- Provide neutral, in-line cervical stabilization
- Provide oxygen
- Assist ventilation, if needed
- Immobilize spine using a backboard
- Keep backboard in a level position, if pt. is hypotensive*
- Monitor vital signs
- Monitor neurological status

**There is little data to support the use of the Trendelenburg position when compare to a flat, level position. Therefore we recommend keeping a hypotensive, backboarded patient in a supine and level position. For patients without a potential spine injury, use the shock position (legs only elevated).*

Spinal Immobilization

Begin spinal immobilization by manually stabilizing the head and aligning the neck in a neutral, in-line position. Next, apply a properly-sized cervical collar.

Rescuers then should carefully move the patient to a backboard. Pad well to fill all voids between the back of the patient and the backboard. Lastly, secure the patient to the backboard.

Elaboration - CMS

Evaluate circulation, motor and sensory (CMS) function in all extremities before and after immobilization. Observe for and document changes.

Elaboration - Manual, Inline Cervical Stabilization

Align the patient's neck to a neutral, in-line position unless you encounter: new pain, new numbness, tingling or weakness, new compromise of airway or ventilation or resistance. Apply a cervical collar and backboard.

If you are unable to align the neck in a neutral, in-line position, then secure the patient in the position found.

When Not to Immobilize the Spine

Not all trauma patients require spinal immobilization. Immobilization may be unnecessary if ALL of the following apply:

- No significant MOI
- No back or neck pain with or without movement
- No pain or tenderness of back or neck on exam
- No altered LOC (must be alert and oriented X 3)
- No history of loss of consciousness
- No recent alcohol or drug use
- Patient is reliable historian*

* No language barrier, psychosis or other mental disability

Elaboration – When to immobilize the spine

Strongly consider immobilization in the following situations:

- Significant MOI
- Pain in neck or back with or without movement
- Altered LOC
- History of altered LOC
- Unreliable historian
- Intoxication with alcohol/drugs
- Very young or elderly with trauma
- Significant injury above femur
- Diving accidents
- Falls greater than 10 feet
- GSW to neck, chest, abdomen, pelvis or groin
- Stabbing in close proximity to spine
- Any significant head injury
- Drowning of unknown cause
- Electrocution and explosion
- Paralysis, numbness, weakness, tingling or burning sensation of the arms or legs

Keys to Successful Spinal Immobilization

The purpose of spinal immobilization is to prevent further injury. To effectively immobilize the spine, you must immobilize the trunk, legs, arms and lastly, the head.

Keys to successful spinal immobilization include:

- Sufficient resources
- Neutral, in-line cervical stabilization (early and throughout)
- Properly-sized cervical collar
- Lightweight, soft and bulky padding in all voids*
- Head secured after the torso has been secured
- Good communication and teamwork
- Check circulation, motor and sensory status (CMS) before and after

* *Thin pad behind the head for an adult, behind the chest for a child.*

Remember, there are risks for the immobilized patient (inability to protect airway, discomfort and pain).

Elaboration – Backboarding Precautions

Treatment of a spine injury with immobilization on a backboard requires several precautions. Remember that patients strapped to a backboard cannot adequately protect their airway and are vulnerable to aspiration of vomitus.

Closely monitor all patients who are immobilized onto a backboard. In addition, remember that elderly patients may have no fat or little muscle mass. Thus a backboard is very uncomfortable for this population.

Helmet Removal

Leave a football helmet and shoulder pads in place if it stabilizes head and does not impair breathing or the airway. The helmet helps keep the spine from hyperextending when a football player is wearing shoulder pads and in the supine position.

If you need to remove a helmet, first manually stabilize the neck and head and remove the face guard. Next remove the chinstrap and have one rescuer stabilize the head while another removes the helmet. Finally, apply cervical collar and backboard.

Always remove motorcycle and bicycle helmets. These types of helmets often cause the head to hyperflex the cervical spine when a patient is in the supine position.

Chest Trauma

Trauma to the thorax can be the result of wide variety of mechanisms such as gun shot wounds, stab wounds, blunt trauma, falls, crush injuries and motor vehicle accidents.

Maintain a high index of suspicion when you encounter any of these mechanisms even when a patient is initially stable. Internal injuries from chest trauma can include:

- Pneumothorax
- Hemothorax
- Tension pneumothorax
- Flail chest
- Traumatic asphyxia
- Myocardial contusion
- Cardiac tamponade
- Lacerations of great vessels (e.g., aortic tear)

Pneumothorax

A pneumothorax is the presence of air in the pleural space. It is caused when an internal or external wound allows air to enter the space between pleural tissues. It can cause a collapse of the lung.

A pneumothorax can cause sharp chest pain and shortness of breath. Breath sounds may be diminished on the side of the pneumothorax. In some cases you may be able to feel subcutaneous air.

Flail Chest

Blunt trauma to the chest can cause severe injuries such as flail chest. A flail chest occurs when three or more adjacent ribs break in two or more places and become a free-floating segment.

A significant force is required to fracture the front and back of the ribs and will likely produce contusions of the heart and lungs that can lead to severe hypoxia.

Symptoms of flail chest include localized pain and dyspnea. You often can observe paradoxical motion in the chest wall where the segment moves in during inspiration and out during expiration.

Traumatic Asphyxia

Traumatic asphyxia occurs when sudden compression of the chest or abdomen forces blood out of the right side of the heart and into the veins of the neck.

The signs include an appearance of strangulation such as cyanosis and swelling of the face, head and neck. Petechiae may be prominent on the face.

Myocardial Contusion

A myocardial contusion is a bruising of the heart muscle. It occurs when blunt trauma to the chest is transmitted via the sternum. Sometimes a force is great enough to rupture the myocardial wall and rapidly empty the heart or cause cardiac tamponade.

Signs and symptoms can include chest pain, respiratory distress, cardiac dysrhythmias, chest wall bruising and tenderness.

Cardiac Tamponade

Cardiac tamponade occurs when a blunt or penetrating trauma to the heart causes blood to rapidly accumulate in the pericardial sac. This inelastic covering of the heart fills with blood and compresses the chambers of the heart to a point that they can no longer fill adequately. This diminishes cardiac refill and cardiac output that leads to shock.

Signs of cardiac tamponade include: tachycardia, breathlessness and decreasing LOC, pallor, cyanosis, respiratory distress, tachypnea, and distended neck veins. Successive

blood pressure measurements may show systolic and diastolic readings that approach one another.

Aortic Tear

An aortic tear occurs when a person's body experiences rapid deceleration. The aortic root and arch shear where they are attached to the heart. Most of these victims die immediately.

Observe for a significant MOI and unexplained shock. Sometimes you will find upper extremity hypertension and diminished lower extremity pulses.

Emergency Care for a Chest Injury

The steps for general management of a chest injury include:

- Ensure ABC's
- Administer high flow oxygen via NRB
- Assist ventilations, if needed
- Anticipate cardiac arrest
- Treat for shock

If you use a bag-valve mask to assist ventilations, be aware of increasing resistance which suggests a tension pneumothorax is developing.

Elaboration - Care for Chest Injury

You must support airway, breathing and circulation in cases of severe chest trauma. Chest injuries may require high-flow oxygen or assist ventilations with a BVM or both. Treat for shock by placing the patient in the shock position. In addition, request a medic unit and initiate rapid transport.

Stabilize a flail chest segment with a bulky dressing and tape.

Elaboration - Care for Open Pneumothorax

For open pneumothorax, apply a sterile occlusive dressing taped on three sides. It should function like a valve that opens when the patient exhales and closes when the patient inhales. You can use any occlusive material, such as plastic packing from your aid kit supplies, to make a valve dressing.

Summary

The main structures of the brain are the cerebrum, cerebellum and brain stem. The brain and spinal cord are well-protected by the skull, vertebrae, meninges and cerebrospinal fluid.

Signs of cerebral edema and increasing intracranial pressure include:

- Irrational or combative behavior
- Changing LOC

- Abnormal respiratory pattern
- Unequal pupils
- Posturing

Emergency care for a potential internal head injury requires these steps:

- Protect the airway
- Provide oxygen and ventilatory assistance, if needed
- Maintain neutral in-line, cervical stabilization and stabilize spine
- Closely monitor vital signs and neurological status
- Control bleeding

The major symptoms you will see in a spine injury are weakness, numbness, tingling, impaired sensation or paralysis in the extremities. Pain in the spinal area is another indication.

You may not need to immobilize the spine if ALL of these conditions are met:

- No significant MOI
- No back or neck pain with or without movement
- No pain or tenderness of back or neck on exam
- No altered level of consciousness (patient must be alert and oriented X 3)
- No history of loss of consciousness
- No recent alcohol or drug use
- Patient is a reliable historian

Emergency care for a spine injury includes manually stabilizing the head and aligning the neck in a neutral, in-line position. Next apply a cervical collar and carefully move the patient and place on a backboard and secure.

Assessment and treatment of the ABCs is your highest priority in all patients with a suspected spine injury.

Signs of an internal chest injury include localized pain and tenderness and possible dyspnea

Chest injuries may require the following care:

- Ensure ABC's
- High flow oxygen via NRB
- Assist ventilations, if needed
- Anticipate cardiac arrest
- Treat for shock