Prehospital Trauma Life Support
Text Overview

Prepared by
Judith M. Haluka

Based on
PHTLS – Basic and Advanced Prehospital Trauma Life Support
Fifth Edition
Mosby, 2003

To be used as a study guide in conjunction with the NAEMT prepared Textbook.

The following is intended to be used as a study guide. It is an outline of the FIFTH EDITION PHTLS TEST Published by Mosby and Copyrighted 2003.

PURPOSE AND MISSION:

The fundamental believe, which has not wavered since 1981, is that DEFINITIVE CARE cannot be provided for the critically injured trauma patient in the field. But that the continuum of care begins at the scene with prehospital trauma management.

GOALS:

1. Rapid and accurate assessment
2. Identification of shock and hypoxemia
3. Initiation of intervention techniques
4. Rapid and safe transportation

GENERAL:

Not only is the number of trauma patients larger than most other patient populations, but the chance of survival of the trauma patient who has been provided good hospital care is greater than that of any other patient.

Trauma is the leading cause of death in persons age one through forty-four. Eighty percent of teenage deaths are secondary to trauma. Sixty percent of childhood deaths are secondary to trauma. Three times more Americans die of trauma each year than died in the Vietnam War. 11 million people are temporarily disabled and 450,000 are permanently disabled each year.

KINEMATICS OF TRAUMA

A complete, accurate history of a traumatic incident and proper interpretation of this information can allow the EMT to predict more than 90% of the patient's injuries before he or she every lays a hand on the patient.

I. PRE-CRASH

Includes all of the events that precede the incident such as the ingestion of alcohol or drugs. Conditions that predate the incident are also part of the precrash phase, such as the patient's acute or pre-existing medical conditions.

II. CRASH PHASE

Begins at the time of impact between one moving object and a second object. The crash phase ends when all motion has stopped.

III. POST CRASH PHASE

Begins as soon as the energy from the crash is absorbed and the patient is traumatized.

KINEMATICS: The process of surveying the scene to determine what injuries might conceivably have resulted from the forces and motion involved.

LAWS OF ENERGY AND MOTION:

NEWTON'S FIRST LAW OF MOTION: A body at rest will remain at rest and a body in motion will remain in motion until acted upon by some outside force.

CONSERVATION OF ENERGY: Energy cannot be created or destroyed but can be changed in form.

KINETIC ENERGY is a function of an object's weight and speed. In humans, the victim's weight as it affects kinetic energy is

Kinetic Energy = ½ of the mass x the velocity squared

The velocity or speed increases the rate of production of kinetic energy more so than mass.

The other factor that must be considered is stopping distance. If the stopping distance is increased, the force of deceleration is decreased and the resulting damage is also decreased. This inverse relation between stopping distance and injury also applies to falls. A person may survive a fall if he or she lands on a compressible surface, such as deep snow. The same fall terminating on a hard surface can be devastating.

Loss of motion of a moving object translates into tissue damage to the victim.

CAVITATION – when a moving object strikes the human body or when the human body is in motion and strikes a stationary object, the tissues of the human body is knocked out of its normal position, creating a hole.

Two types of cavities are created:

Temporary Cavity – forms at the time of impact, but depending on the elasticity of the tissue, it can return to its previous position. (May not be visible when the provider arrives on scene)

Permanent Cavity – forms at the time of impact and is caused by compression or tearing of tissue. It is also caused partly by stretch, but because it does not rebound to its original shape, it can be seen later.

The size difference between the two cavities is related to the elasticity of the tissue involved. A complete history of the incident will allow the provider to determine the approximate size of the cavity at the time of impact and accurately predict injuries.

The DENSITY of the tissue and the SURFACE AREA OF THE IMPACT determine the number of tissue particles affected

DENSITY – The denser a tissue, the greater number of particles that will be hit by a moving object. The body has three different types of tissue densities – air (lung and intestine), water (muscle and most solid organs such as liver and spleen) and bone.

FRONTAL SURFACE AREA – the size of the object, its motion within the body, and fragmentation can modify the surface area.

BLUNT TRAUMA

Two forces are involved in the impact – shear and compression. Shear is the result of one organ or structure changing speed faster than another organ or structure. Compression is the result of an organ or structure being directly squeezed between other organs or structures.

Motor Vehicle Crashes

Three collisions occur:

1. The vehicle collides with an object or with another vehicle
2. The unrestrained occupant collides with the inside of the vehicle
3. The occupant's internal organs collide with one another or with the wall of the cavity that contains them

Each of these collisions causes a different kind of damage, and each must be considered separately in analyzing the incident.

FRONTAL IMPACT – the damage to the vehicle indicates the approximate speed of the vehicle at the time of impact. There are two possible paths of injury.

UP AND OVER: The head leads striking the windshield. The chest or abdomen collides with the steering wheel. If the chest strikes the steering wheel, serious injury to the thoracic cage, soft tissues or organs can occur. If the abdomen strikes it, compression injuries can occur, most often to solid organs. The continued forward motion of the kidneys tear renal arteries or veins where they attach to the aorta or vena cava.

DOWN AND UNDER: The foot with a straight knee can twist as the torso motion angulates and fractures the ankle joint. The knee has two possible impact points; the tibia and the femur. If the tibia hits the dashboard and stops first, the femur remains in motion and overrides it. A dislocated knee with torn ligaments, tendons and other supporting structures can result. A blood clot may result in significantly decreased blood flow to the leg tissues below the knee. Early recognition of a popliteal artery injury and prompt surgical repair restores blood flow to the calf and foot and significantly decreases the subsequent need for an amputation. An imprint on the dash where the knee impacted is a key indicator that significant energy was focused on this joint and adjacent structures.

When the femur is the point of impact, the energy is absorbed on the bone shaft which can break. The continued forward motion of the pelvis onto the femur that remains intact can override the femur's head resulting in a posterior dislocation of the joint.

If the headrest is not positioned to move the head with the torso then the body in contact with the vehicle is accelerated out from underneath the head. This results in hyperextension of the neck over the top of the headrest, tearing ligaments and supporting anterior structures.

LATERAL IMPACT: The side of the vehicle or the door is thrust against the side of the occupant. Injuries may occur in three ways;

1. by impact with the vehicle
2. by impact with other unrestrained passengers
3. by the door's projection into the passenger compartment as it is bent inward

ROTATIONAL IMPACT: result in injuries that are a combination of those seen in frontal and lateral impacts.

ROLLOVER: undergo several impacts at many different angles, as may the occupant's body and internal organs. Injuries can rarely be predicted.

RESTRAINT FACTS

75% of passenger vehicle occupants who were totally ejected were killed. One out of thirteen sustain a spinal fracture. The second impact results in injuries that are even more severe that the initial impact. The risk of death for ejected victims is six times greater than for those who are not ejected.

The proper use of restrains transfers the force of the impact from the patient to the restraint system greatly reducing injury. However the belts are designed to hold the patient by the pelvic girdle. When lap belts are worn loosely or are strapped above the anterior iliac crests, compression injuries of the soft abdominal organs can occur. Increased intraabdominal pressure can cause diaphragmatic rupture and herniation of abdominal organs.

MOTORCYCLE CRASHES

Head on Impact: The rider crashes into the handlebars. If the rider's feet remain on the pegs and the thighs hit the handlebars, the forward motion will be absorbed by the mid shaft femur, commonly resulting in bilateral femur fractures. Head, chest and abdominal injuries are also quite common.

Angular Impact: The motorcycle collapses on the rider or causes the rider to be crushed between the motorcycle and the object struck.

Ejection: The rider is thrown from the cycle like a missile. Injury will occur at the point of impact and radiate to the rest of the body as the energy is absorbed. The potential for serious injury is high as the rider is unprotected.

*Laying the bike down is protective maneuver used by professional racers and some street bikers to separate themselves from the bike in an impending crash. The rider turns the bike sideways and drags their inside leg on the ground slowing themselves more than the cycle. These riders usually get abrasions (road rash) and minor fractures but avoid the severe injuries associated with more severe kinds of impacts.

PEDESTRIAN INJURY

There is a difference in injury pattern dependant on age. The adult will try to protect themselves by turning away so injuries are frequently lateral or even posterior. Children will often face the vehicle resulting in anterior injuries. Because of the difference in height the injury patterns will differ.

1. The initial impact is to the legs and sometimes hips.
2. The torso rolls onto the hood of the vehicle
3. The victim falls off the vehicle and onto the ground usually head first with possible cervical spine trauma

SPORTS INJURIES

Caused by sudden deceleration forces or by excessive compression, twisting, hyperextension, or hyperflexion. While assessing the victim the provider should consider the following:

- What forces acted on the victim and how?
- What are the apparent injuries?
- To what object or part of the body was the energy transmitted?
- What other injuries are likely to have been produced by this energy transfer?
- Was protective gear being worn?
- Was there sudden compression, deceleration of acceleration?
- What injury-producing movements occurred?

Broken or damaged equipment is also an important indicator of injury and must be included in the evaluation of the mechanism of injury. Broken protective equipment usually indicates significant force. Each victim should be evaluated thoroughly before moving him or her form the scene. The prehospital provider should do the following:

- Evaluate the patient for life-threatening injury
- Evaluate the patient for mechanism of injury
- Determine how the forces that produced injury in one victim may have affected any other person
- Determine whether protective gear was worn or removed
- Assess damage to equipment
- Assess patient for possible associated injuries

BLAST INJURIES

Primary Injures are caused by the pressure wave of the blast. They usually occur in the gas containing organs such as the lungs and gastrointestinal tract. Include pulmonary bleeding, pneumothorax, air emboli or perforation of the GI organs. May injury central nervous system. Burns from the heat wave are common. Waves may cause severe damage or death without external signs of injury.

Secondary Injuries occur when the victim is struck by flying glass, falling mortar or other debris from the blast

Tertiary injuries occur when the victim becomes a missile and is thrown against an object.

Secondary and tertiary injuries are the most obvious and are usually the most aggressively treated. Primary injuries may be the most severe, but are often overlooked and sometimes never suspected.

REGIONAL EFFECTS OF BLUNT TRAUMA

HEAD: The only indication that compression and shear injuries have occurred to the patient's head may be a soft tissue injury to the scalp, a contusion of the scalp, or a bull's eye fracture of the windshield.

COMPRESSION: The head is the first to receive the impact and the energy exchange. The momentum of the torso compresses the head. The skull can be compressed and fractured, pushing the bony segments of the skull into the brain.

SHEAR: After the skull stops its forward motion, the brain continues to move forward becoming compressed against the intact or fractured skull resulting in concussion, contusions or lacerations. Hemorrhage into the epidural, subdural or subarachnoid space can result. If the brain separates from the spinal cord, it will most likely occur at the brain stem.

NECK:

COMPRESSION: The continued pressure from the momentum of the torso toward the stationary skull produces angulation or compression. Hyperextension or hyperflexion of the neck results in fracture or Dislocation of the vertebrae and injury to the spinal cord.

SHEAR: The center of gravity is anterior and cephalad to the point at which the skull attaches to the bony spine. A lateral impact on the torso when the neck is unrestrained will produce lateral flexion and rotation of the neck. Causes stretching injuries to the soft tissues of the neck.

THORAX:

COMPRESSION: Common with frontal and lateral impacts and Produces a phenomenon called the *paper bag effect,* which may result in a pneumothorax. A victim takes a deep breath and holds it just before impact. This closes the glottis, effectively seals off the lungs. With impact the lungs may then burst like a paper bag full of air.

SHEAR: The heart, ascending aorta and aortic arch are relatively Unrestrained within the thorax. The aorta tightly adheres to the Posterior thoracic wall and vertebral column. The aorta can be Transected and separated resulting in immediate exsanguinations or require emergent surgery for repair.

ABDOMEN:

COMPRESSION: Internal organs pressed by the vertebral column into the steering wheel or dash during a front impact may rupture. The diaphragm is the weakest of all the walls and structures surrounding the abdominal cavity. It may be torn or ruptured as the intraabdominal pressure increases. This injury has four common consequences:

1. The "bellows" effect normally created by the diaphragm as an integral part of breathing is lost.
2. The abdominal organs can enter the thoracic cavity and reduce the space available for lung expansion.
3. The displaced organs can become ischemic from compression of their blood supply.
4. If intraabdominal hemorrhage is present, the blood can alos cause a hemothorac.

SHEAR: Occurs at their points of attachment to the mesentery. During a collision, the forward motion of the body stops, but the organs continue to move forward causing tears at the points of attachment to the abdominal wall. Laceration of the liver occurs with itsd impact with the legamentum teres. The liver is suspended from the diaphragm but is only minimally attached to the posterior abdomen near the lumbar vertebrae.

PENETRATING TRAUMA

Energy cannot be created or destroyed, but it can be changed in form. According to Newton's first law of motion, after this force has acted upon the missile, the bullet will remain at that speed and force until it is acted upon by an outside force. When the bullet hits something, such as a human body, it strikes the individual tissue cells. The energy of the bullet's motion is exchanged for the energy that crushes these cells and moves them away (cavitation) from the path of the bullet.

Size of the Frontal Area – the larger the frontal area of the moving missile, the greater the number of particles that will be hit; therefore the greater the energy exchange that occurs and the larger the cavity that is created.

Profile – describes an object's initial size and whether that size changes at the time of impact. The profile of an ice pick is much smaller than that of a baseall.

Tumble – describes whether the object tumbles and assumes a different angle inside the body than the angle assumed as it entered the body.

Fragmentation – describes whether the object breaks up after it enters the body. Bullets such as those with soft noses, vertical cuts in the nose and safety slugs that contain many small fragments increase body damage by breaking apart on impact.

Damage and Energy Levels

The prehospital provider can estimate damage caused in a penetrating injury according to its energy capacity.

Low Energy Weapons – include hand-driven weapons such as a knife or ice pick. These produce damage only with their sharp points or cutting edges and are usually associated with les secondary trauma. Injury can be predicted by tracing the path of the weapon into the body. Always look for more than one injury. An attacker may stab a victim and then move the knife around inside the body. A simple entrance wound may give the care provider a false sense of security.

Medium and High Energy Weapons

Firearms fall into two groups – medium and high energy. Medium include handguns and some rifles. As the amount of gunpowder increases in the cartridge the speed of the bullet and therefore its kinetic energy increases.

In general damage not only the tissue directly in the path of the missile but also the tissue on each site of the missile's path. The variables of profile, tumble and fragmentation influence the extent and direction of the injury. A temporary cavity is always associated with weapons in the category. This cavity is usually three to six times the size of the missile's frontal surface area.

High energy weapons include assault weapons, hunting rifles and other weapons that discharge high velocity missiles. They create a permanent track and produce a much larger temporary cavity than lower velocity missiles. The cavity expand well beyond the limits of the actual bullet track and damages and injures a wider area than is apparent during the initial assessment.

A consideration in predicting the damage from a gunshot wound is the range or distance form which the gun is fired. Air resistance slows the bullet; therefore increasing the distance will decrease the velocity at the time of impact and result in less injury.

Entrance and Exit Wounds – Should evaluate entrance and exit wounds. Tissue damage will occur at the site of entry into the body, in the path of the weapon's entrance and upon exit from the body. Knowledge of the victim's position, the attacker's position, and the weapon used is essential in determining the path of injury.

Entrance wound lies against the underlying tissue, but an exit wound has no support. An entrance wound is round or oval depending on the entry path and the exit wound is a stellate (starburst) wound.

Regional Effects of Penetrating Trauma

Head – After a missile penetrates the skull, its energy is distributed within a closed space. Particles accelerating away from the missile are forced against the unyielding skull. The brain tissue is compressed against the inside of the skull producing more injury that if it could expand freely. A bullet may follow the curvature of the interior of the skull if it enters at an angle and has insufficient force to exit the skull. This path can produce significant damage. This is characteristic of medium velocity weapons such as 22 caliber pistols.

Thorax – Three major groups of structures; pulmonary system, vascular system and gastrointestinal tract.

1) Pulmonary – Lung tissue is less dense than blood, solid organs or bond; therefore a penetrating object does less damage to lung tissue than to other thoracic tissues.
2) Vascular System – smaller vessels that are not attached to the chest wall may be pushed aside without significant damage. Larger vessels, such as aorta and vena cava, are hit, they cannot move aside easily and are more susceptible to damage. The myocardium stretches as the bullet passes through and then contracts, leaving a smaller defect.
3) Gastrointestinal Tract – The esophagus can be penetrated and can leak its contents into the thoracic cavity. The signs and symptoms may be delayed for several hours or days.

Abdomen – Three types of organs; air filled, solid and bony. Penetration by a low energy missile may not cause significant damage; only 30% of knife wounds penetrating the abdomen require surgery. A medium energy injury is more damaging 85-95% requiring surgical intervention.

ASSESSMENT AND MANAGEMENT
CHAPTER THREE

Assessment is the cornerstone of excellent patient care. Assessment is the foundation upon which all management and transportation decisions are based. The first goal is to determine a patient's current condition.

- ❑ Develop an overall impression of condition
- ❑ Establish baseline values for status of respiratory, circulatory and neurologic systems.

- Rapidly asses life threatening conditions
- Initiate urgent intervention and resuscitation

Critical patients cannot remain in the field for care other than that needed to stabilize them for transport, unless they are trapped or other complications exist that prevent early transportation.

Primary concerns for assessment and management:

1) Airway
2) Ventilation
3) Oxygenation
4) Hemorrhage Control
5) Perfusion

Scene time should not exceed 10 minutes; the shorter the better.

Establishing Priorities

1. The first priority for everyone is scene assessment. Involves establishing that the scene is safe and carefully considering the exact nature of the situation.
2. Begin assessment and management of the patients who have been identified as the most critical as resources allow
    a. Conditions that may result in the loss of life
    b. Conditions that may result in the loss of limb
    c. All other conditions that do not threaten life or limb

The prehospital provider may never address the conditions that do not threaten life or limb.

3. The prehospital care provider must recognize the existence of multiple patient incidents and mass casualty incidents. In these incidents the priority shifts from focusing all resources on the most injured patient to saving the maximum number of patients.

Scene Assessment and Size-Up

1. Safety – If the scene is unsafe, the prehospital provider should stand clear until appropriate personnel have secured the scene. Patient safety is also important. The patient must be moved from any potentially hazardous environment.
2. Situation – What really happened here? What is the mechanism of injury? What forces led to the injury? Are other resources needed to handle the situation.
3. Standard Precautions – should be used when dealing with any patient, particularly trauma. They include gloves, gowns, masks and goggles.

Primary Survey (Initial Assessment)

Rapid identification and management of life-threatening conditions. 90% of patients have simple injuries that involve only one system. For these patients, the prehospital provider has time to be thorough in both the primary and secondary surveys.

For the critically injured patient, the provider may never conduct more than a primary survey. The emphasis is on rapid evaluation, initiation of resuscitation and transportation to an appropriate facility. Does not eliminate the need for management but it must be done faster, more efficiently and enroute to the hospital.

Three components are necessary for normal metabolism:

1) Oxygenation of the red blood cells in the lung
2) Delivery of RBCs to the cells throughout the body
3) Offloading of oxygen to these cells

GENERAL IMPRESSION

Simultaneous, or global overview of the status of the patient's respiratory, circulatory and neurologic systems to identify obvious significant external problems with oxygenation, circulation, hemorrhage or gross deformities.

Within 15-30 seconds, the prehospital care provider has gained a general impression of the patient's overall condition. Establishes whether the patient is presently or imminently in a critical condition and rapidly evaluates the patient's overall systemic condition.

This is when the decision regarding ground vs air transport should be made. Early decision making will ultimately shorten scene time.

AIRWAY MANAGEMENT AND CERVICAL SPINE STABILIZATION

Ensure airway is patent and that no danger of obstruction exists. If the airway is compromised, the provider should open it initially using manual methods and clear blood and body substances if necessary.

Every trauma patient with a significant mechanism of injury is suspected of spinal injury until it is ruled out. The solution is to ensure that the patient's neck is manually maintained in the neutral position during the opening of the airway and the administration of necessary ventilation.

Breathing

1) Check for breathing
2) If the patient is not breathing, immediately begin assisting ventilation before continuing assessment
3) Ensure that the patient's airway is patent, and prepare to insert an oral nasal airway, intubate, or provide other means of mechanical airway protection.

4) If the patient is breathing, estimate the adequacy of the ventilatory rate and depth. Ensure that the inspired oxygen concentration is 85% or greater.
5) Quickly observe the patient's chest rise, and if the patient is conscious listen to the patient talk to assess whether he or she can speak a full sentence without difficulty.

Ventilatory Rate (Divided into 5 Levels)

1) Apneic
2) Slow – a low ventilatory rate may indicate ischemia of the brain. If rate has dropped to less than 12 the provider must either assist or completely take over breathing
3) Normal – Between 12-20 breaths per minutes
4) Fast – Between 20 and 30/min the patient should be watched closely. When a patient displays an abnormal ventilatory rate, the provider should investigate why. A rapid rate indicates that not enough oxygen is reaching the body tissue. This lack of oxygen initiates the anaerobic metabolism and ultimately an increase in CO2. This may indicate tha the patient needs better perfusion or oxygenation or both. Administration of supplemental oxygen to achieve an oxygen concentration of 85% or greater.
5) Abnormally Fast – A ventilatory rate above 30 indicates hypoxia, anaerobic metabolism or both with a resultant acidosis. Immediately begin assisted ventilation that achieves an oxygen concentration of 85% or greater. A search for the cause of the rapid ventilatory rate should begin at once.

CIRCULATION AND BLEEDING – Oxygenation of the RBC's without delivery to the tissue cells is of no benefit to the patient.

1. Capillary bleeding – caused by abrasions that have scraped open the tiny capillaries just below the skins surface. Easily stoppable.
2. Venous Bleeding – deeper within the tissue and is usually controlled with a small amount of direct pressure.
3. Arterial Bleeding – laceration of an artery. Most difficult type of blood loss to control. Spurting briht red. Even a small, deep arterial puncture can produce life-threatening arterial blood loss.

Hemorrhage is controlled in the prehospital setting by:

1. Direct Pressure to the site of bleeding
2. Elevation
3. Pressure to an artery proximal to the wound
4. Tourniquets – as a last resort only.

Hemorrhage control is a priority. Rapid control of blood loss is one of the most important goals in the care of a trauma patient. The primary survey cannot advanced unless bleeding is controlled.

PERFUSION – can obtain overall perfusion status by checking the pulse; skin color, temperature and moisture and capillary refill time.

1. Pulse – presence, quality and regularity. Also provides a rough estimate of blood pressure. If the radial pulse is not present in an uninjured extremity, that patient has likely entered the Decompensated phase of shock, a late sign of the patient's critical condition. In the primary survey an exact pulse rate is not necessary. A gross estimate can be rapidly obtained.
2. Skin – Color, Adequate perfusion produces a pinkish hue to the skin. Skin becomes pale when blood is shunted away from an area. Bluish coloration indicates incomplete oxygenation. Examination of the nail beds and mucous membranes serves to overcome the difference in skin pigments. Changes in color first appear in lips, gums or fingertips.
    a. Temperature – is influenced by environmental conditions. Cool skin indicates decreased perfusion, regardless of cause.
    b. Moisture – dry skin indicates good perfusion. Moist skin is associated with shock and decreased perfusion.

3. Capillary Refill Time – check by pressing over the nail beds. Tool in estimating blood flow through the most distal part of the circulation. Should be less than 2 seconds. By itself it is a poor indicator of shock because it is influenced by so many other factors. Maintains a place in evaluation; the provider should use it in conjunction with other physical examination findings.

DISABILITY

Assessment of cerebral function which is an indirect measurement of cerebral oxygenation. The goal is to determine the patient's LOC and ascertain the potential for hypoxia. A belligerent, combative, or uncooperative patient is hypoxic until proven otherwise. Determine whether the patient has lost consciousness at any time since the injury. A decreased LOC has four possibilities.

1. Decreased cerebral oxygenation (due to hypoxia and/or hypoperfusion)
2. Central nervous system injury
3. Drug or Alcohol overdose
4. Metabolic derangement (diabetes, seizure, cardiac arrest, etc.)

Glasgow Coma Scale is a tool used for determining LOC. A GCS of less than 14 in combination with an abnormal pupil examination can indicate the presence of a life threatening traumatic brain injury.

GLASCOW COMA SCALE

	Points
EYE OPENING	
Spontaneous eye opening	4
Eye opening on command	3

Eye opening to painful stimuli	2
No eye opening	1

BEST VERBAL RESPONSE

Answers appropriately (oriented)	5
Gives confused answers	4
Inappropriate response	3
Makes unintelligible response	2
Makes no verbal response	1

BEST MOTOR RESPONSE

Follows Commands	6
Localizes painful stimuli	5
Withdrawal to pain	4
Response with abnormal flexion (decorticate)	3
Response with abnormal extension (decerebrate)	2
Gives no motor response	1

AVPU can also be used to assess LOC. Quicker but provides less useful information. GCS is a key assessment performed in the emergency department and throughout a patient's hospital stay, the provider should use it in the field to provide important baseline assessment

A = Alert
V= Response to verbal stimulus
P=Responds to painful stimulus
U=Unresponsive

EXPOSE/ENVIRONMENT

Remove the patient's clothes because exposure of the trauma patient is critical to finding all injuries. Blood can collect in clothing and go undetected. Although it is important to expose the patient, hypothermia is a serious problem in the prehospital setting. Only what is necessary should be exposed to the outside environment.

RESUSCITATION

Describes treatment steps taken to correct life-threatening problems as identified in the primary survey.

LIMITED SCENE INTERVENTION

1. Manages airway problems as the top priority
    a. Initiates ventilatory support
    b. Administers oxygen to maintain an 02 sat of 85% or greater as early as possible.

2. Controls exsanguinating hemorrhage.

TRANSPORT

If life-threatening conditions are identified during primary survey the patient should be rapidly packaged after initiating limited field intervention. Unless extenuating circumstances exist, limit scene time to 10 minutes or less if any of the following conditions exist.

- Inadequate or threatened airway
- Impaired ventilation as demonstrated by;
  - Abnormally fast or slow respiratory rate
  - Hypoxia
  - Dyspnea
  - Open pneumothorax or flail chest
  - Suspected pneumothorax

- Significant external hemorrhage or suspected internal hemorrhage
- Abnormal neurologic status
  - GCS <13
  - Seizure activity
  - Sensory or motor deficit

- Penetrating trauma to the head, neck, or torso or proximal to the elbow and knee in the extremities
- Amputation or near amputation proximal to the fingers or toes
- Any trauma in the presence of the following;
  - History of serious medical conditions such as coronary disease, chronic obstructive pulmonary disease, bleeding disorder
  - Age >55 years
  - Hypothermia
  - Burns
  - Pregnancy

FLUID THERAPY

Restoration of the cardiovascular system to an adequate perfusion volume as quickly as possible. Lactated Ringers is the preferred solution for trauma resuscitation. Crystalloid such as lactated ringers do not replace the oxygen carrying capacity of RBCs or the lost platelets that are necessary for clotting and bleeding control Therefore rapid transportation is necessary. Enroute two large bore IV's in the forearm or antecubital should be started. In general, central IV lines are not appropriate for field management. 1-2L of warmed lactated ringers should be administered enroute.

BASIC LIFE SUPPORT TRANSPORT

If transportation time is prolonged, it may be appropriate to call for aid from a nearby ALS service that can intercept enroute. Helicopter evacuation to a trauma center is another option. Either will allow advanced airway management, ventilatory management and earlier fluid resuscitation.

SECONDARY SURVEY (FOCUSED HISTORY AND PHYSICAL EXAMINATION)

The prehospital provider must complete the primary survey, identify and treat all life threatening injuries and initiate resuscitation before beginning the secondary survey. Deals with less serious injuries. Should not hold patient in the field for IV starts or for secondary assessment.

SEE – don't just look (perceive with the eye)
HEAR – don't just listen (to monitory with participation)
FEEL – don't just touch

SEE

- Examine all the skin of each region
- Be attentive for external hemorrhage or signs of internal hemorrhage such as marked tenseness of an extremity or expanding hematoma.
- Make note of soft tissue injuries, including abrasions, burns, contusions, hematomas, lacerations and punctures wounds
- Make note of any masses or swelling or deformation of bones that should not be present.
- Make note of abnormal indentations of the skin and the skin's color
- Make not of anything that "doesn't look right"

HEAR

- Make note of any unusual sounds when the patient inhales or exhales.
- Make note of any abnormal sounds when auscultating the chest
- Verify whether the breath sounds are equal in both lung fields
- Auscultate over the carotid arteries and other vessels
- Make note of any unusual sounds (bruits) over the vessels that would indicate vascular damage.

FEEL

- Carefully move each bone in the region. Note whether this produces crepitus, pain or unusual movement
- Firmly palpate all parts of the region. Note whether anything moves that should not, whether anything feels "squishy" where pulses are felt, whether pulses are felt that should not be present, and whether pulses are present.

VITAL SIGNS – Complete set of vital signs include blood pressure, pulse rate and quality, ventilatory rate including breath sounds, and skin color and temperature. Vital signs should be repeated every 3-5 minutes.

AMPLE HISTORY – quick history on the patient

A – Allergies
M – Medications – both prescription and non-prescription drugs that the Patient takes regularly
P – Past medical and surgical history
L – Last meal – many trauma patients will require surgery
E – Events leading up to the injury

HEAD

Note contusions, abrasions, lacerations, bone asymmetry, hemorrhage, bony defects of the face and supportive skull and mandible.

- Searches thoroughly through the patient's hair for the presence of any soft tissue injuries
- Checks pupil size for reactivity to light, equality, accommodation, roundness or irregular shape
- Carefully palpates the bones of the face and skull to identify crepitus, deviation, depression or abnormal mobility.

NECK

Check for contusions, abrasions, lacerations and deformities. This may indicate an underlying injury. Lack of tenderness of the cervical spine may help rule out cervical spine fractures (when combined with strict criteria), whereas tenderness may frequently indicate the presence of a fracture, dislocation or ligamentous injury.

CHEST

Because the thorax is strong, resilient and elastic, it can absorb a significant amount of trauma.

Except for the eyes, the stethoscope is the most important instrument in the examination of the chest.

Abdomen

Look near the umbilicus for telltale transverse contusion which suggests than an incorrectly worn seat belt has caused underlying injury. Almost 50% of patients with this sign will have an intestinal injury. Lumbar spine fractures may also be associated with the "seat belt sign"

- Palpation of each quadrant to evaluate for tenderness, muscle guarding and masses.
- Note whether soft or rigid with guarding
- Do not continue to palpate if pain is present.

PELVIS

Pelvic fractures can produce massive internal hemorrhage resulting in rapid deterioration.

- The pelvis is palpated only once for instability as part of the secondary survey
- Palpation can aggravate hemorrhage. Palpation is done by gently applying first anterior to posterior pressure with the heels of the hands on the symphysis pubis and then medial pressure to the iliac crests bilaterally evaluating for pain and abnormal movement.

BACK

Best examined by logrolling the patient for placement onto the back board. The spine should be palpated for tenderness and deformity.

EXTREMITIES

Begin exam with clavicles in the upper extremity and the pelvis in the lower extremity and proceed toward the most distal portion of each extremity.

NEUROLOGICAL EXAMINATION

Conducts the neurologic exam in the secondary survey in much greater detail than in the primary survey. Calculation of the GCS score, evaluation of motor and sensory function and observation of papillary response are all included. A significant portion of the population has pupils of different size, however even in this situation, the pupils should react to light in a similar manner. Pupils that react at differing speeds to the introduction of light are considered to be unequal and may indicate increased intracranial pressure or pressure on the third cranial nerve.

A gross examination of sensory capability and response will determine the presence or absence of weakness or loss of sensation in the extremities. The entire body must be immobilized. Use of a long backboard, cervical collar, head pads and straps is required. THE HEAD MUST NEVER BE IMMOBILIZED FIRST OR ALONE.

DEFINITIVE CARE IN THE FIELD

For a patient in cardiac arrest, definitive care is defibrillation with resultant normal rhythm, - CPR is just a holding pattern until defibrillation can be accomplished.

For the patient with severe bleeding, definitive care is hemorrhage control and resuscitation from shock. In general definitive care can only be provided in the OR. Anything that delays administration of that definitive care will lessen the patient's chance for survival.

PACKAGING

- Carefully stabilize extremity fractures using specific splints
- If the patient is in critical condition, immobilize all fractures as the patient is stabilized on a long back board.
- Bandage wounds as necessary and appropriate if time permits.

TRANSPORT

Transportation should begin as soon as the patient is loaded and stabilized. Continued evaluation and further resuscitation occur en route to the receiving facility. **For some critically injured trauma patients, initiation of transport is the most important aspect of definitive care in the field.**

A patient who is not critical can receive attention for individual injuries before transportation, but even this patient should be transported rapidly before a hidden condition becomes critical.

TRIAGE

The Triage Decision Scheme divides triage into three prioritized steps that will assist in the decision as to when it is best to transport a patient to a trauma center if available:

1. Physiological criteria
2. Anatomic criteria
3. Mechanism of injury (Kinematics)

Following this scheme results in overtriage but this outcome is better than undertriage. If the patient's injuries are severe or indicate the possibility of continued hemorrhage, the provider should take the patientto a facility that will provide definitive care as soon as possible.

MONITORING AND REASSESSMENT

Reassess vital signs, and repeat the primary survey several times while en route to the receiving facility, or at the scene if transport is delayed. Help ensure that unrecognized compromise of vital functions does not occur. Pay attention to any change in a patient's condition and reevalaute management if the patient's condition changes. Helps reveal conditions or problems that may have been overlooked during the primary survey.

COMMUNICATION

Should begin communication with medical direction and the receiving facility as soon as possible; giving the receiving facility time to prepare.

Written report:

1. Gives the receiving staff a thorough understanding of the events that occurred and of the patient's condition should any questions arise after the prehospital care providers have left.
2. It helps to ensure quality control throughout the prehospital system by making care review possible. The report should stay with the patient; it is of little use if it does not arrive until hours after the patient arrives.
3. The report is considered to be a complete record of the injuries found and actions taken. If it is not on the report, it was not done is a good adage to remember.

The prehospital provider must verbally transfer the patient. The verbal report is more detailed than the radio report and less detailed than the written report, providing an overview of the significant history of the incident, the action taken by the prehospital care providers and the patient's response to this action.

SCENE TRIAGE

Triage means to sort. The purpose is to salvage the greatest possible number Of patients given the circumstances and resources available. Make decisions about who to manage first. For example, treating the severe head trauma patient first will probably result in the loss of both patients.

1. IMMEDIATE – patients whose injuries are critical but who will require only minimal time or equipment to manage and who have a good prognosis for survival. (Compromised airway, massive external bleeding)
2. DELAYED – Patients whose injuries are debilitating but who do not require immediate management to salvage life or limb. (Long Bone Fractures)
3. EXPECTANT – patients whose injuries are so severe that they have only a minimal chance of survival. (90% full thickness burns)
4. MINIMAL – patients who have minor injuries that can wait for treatment or who may even assist in the interim by comforting other patients or helping out as litter bearers.
5. DEAD – patients who are unresponsive, pulseless and breathless. In as disaster resources rarely allow for attempted resuscitation of arrested patients.

CHAPTER FOUR
AIRWAY MANAGEMENT AND VENTILATION

Three Primary Functions:

1. The system provides oxygen to the red blood cells, which carry the oxygen to all the cells in the body.
2. In aerobic metabolism, the cells use this oxygen as fuel to produce energy.
3. The system removes carbon dioxide from the body.

Inability of the respiratory system to provide oxygen to the cells or the cells to use the oxygen can quickly lead to death.

PHYSIOLOGY

Oxygen moves from the alveoli across the membrane and into the red blood cells. The circulatory system delivers to body tissues where oxygen used as fuel for metabolism. As oxygen is transferred from inside the alveoli to the RBC, carbon dioxide is exchanged in the opposite direction, from the plasm to the aveoli. The alveoli must constantly be replenished with a fresh supply of air that contains an adequate amount of oxygen. This replenishment of air, know as ventilation is essential for the elimination of carbon dioxide. The size of each breath, called the tidal volume, multiplied by the ventilatory rate for one minute equals the minute volume.

MINUTE VOLUEM = TIDAL VOLUME X VENTILATORY RATE/MIN

Hypoventilation leads to buildup of carbon dioxide in the body. Hypoventilation is common when head or chest trauma causes an altered breathing pattern or an inability to move the chest wall adequately.

OXYGENATION AND VENTILATION OF THE TRAUMA PATIENT

1. EXTERNAL RESPIRATION – is the transfer of oxygen molecules from the atmosphere to the blood. All alveolar oxygen exists as free pas; therefore each oxygen molecule exerts pressure. Increasing the percentage of oxygen in the inspired atmosphere will increase alveolar oxygen tension.
2. OXYGEN DELIVERY – is the result of oxygen transfer from the atmosphere to the RBC during ventilation and the transportation of these RBCs to the tissues via the cardiovascular system. This process primarily involves cardiac output, hemoglobin concentrations and oxygemoglobin saturation.
3. INTERNAL RESPIRATION – is the movement or diffusion of oxygen between RBCs into the tissue cells. Metabolism normally occurs via glycolysis and the Kreb's cycle to produce energy and remove byproducts of carbon dioxide and water.

Adequate oxygenation depends on all three of these phases. Although the ability to assess tissue oxygenation in prehospital situations is improving rapidly, all trauma patients must receive appropriate ventilatory support with supplemental oxygen to ensure that hypoxia is correctly or averted entirely.

Trauma can affect the respiratory system's ability to adequately provide oxygen and eliminate carbon dioxide in the following ways:

1. Hypoventilation can result from loss of ventilatory drive, usually because of decreased neurologic function.
2. Hypoventilation can result from obstruction of air flow through the upper and lower airways.
3. Hypoventilation can be caused by decreased expansion of the lungs.
4. Hypoxia can result from decreased diffusion of oxygen across the alveolar capillary membrane
5. Hypoxia can be caused by decreased blood flow to the alveoli
6. Hypoxia can result from the inability of the air to reach the capillaries, usually because the aveoli are filled with fluid or debris.
7. Hypoxia can be caused at the cellular level by decreased blood flow to the tissue cells.

DECREASED NEUROLOGIC FUNCTION

Decreased minute volume can result from two clinical conditions related to decreased neurological function; flaccidity of the otongue and a decreased level of consciousness.

Ventilatory drive temporarily ceases within the first 4-5 minutes after a brain injury. The resulting hypoxic injury can in some cases lead to permanent damage. If treated rapidly and aggressively permanent damage may be prevented.

MECHANICAL OBSTRUCTION

Source can be neurologically influenced or purely mechanical in nature. Foreign bodies in the oral cavity may become lodged and create occlusions in the hypopharynx or the larynx. Crush injuries to the larynx and edema of the vocal cords must be considered. Patients with facial injuries present with two of the most common foreign body obstructions, blood and vomit. Upper and lower airway obstructions can also be caused by bone or cartilage collapse as a result of a fractured larynx or trachea.

MANAGEMENT

Ensuring a patent airway is the first priority of trauma management and resuscitation. Must keep the possibility of a cervical fracture in mind.

Manual clearing of the airway is the first step. Foreign material should be removed with a gloved hand.

In unresponsive patients the tongue becomes flaccid falling back and blocking the hypopharynx. The tongue is the most common cause of airway obstruction.

- TRAUMA JAW THRUST – In cases of suspected head, neck or facial trauma. Allows the provider to open the airway with little or no movement of the head and cervical sine. The mandible is forced forward by placing the thumbs on each cheekbone, placing the index and long fingers on the mandible and at the same angle, pushing the mandible forward.
- TRAUMA CHIN LIFT – ideally used to relieve a variety of anatomic airway obstructions in patients who are breathing spontaneously. The chin and lower incisors are grasped and then lifted to pull the mandible forward.

SUCTIONING

The most significant complication of suctioning is prolonged periods of time will produce hypoxemia that may manifest as a cardiac abnormality such as initial tachycardia. Preoxygenation will help prevent hypoxemia.

1. Preoxygenate the trauma patient with 100% oxygen
2. Insert the catheter without suction. Suctioning is continued for up to 15-30 seconds.
3. Reoxygenate the patient and ventilate for at least 5 assisted ventilations.

Oropharyngeal Airway

Indications

- Patient who is unable to maintain his or her airway
- To prevent an intubated patient from biting an Endotracheal tube

Contraindications

- Patient who is conscious or semiconscious

Complications

- Because it stimulates the gage reflex, use of the OPA may lead to gagging, vomiting and laryngospasm in patients who are conscious.

Nasopharyngeal Airway

Indications

- Patient who is unable to maintain his or her airway

Contraindication

- No need for an airway adjunct

Complications

- Bleeding caused by insertion

Dual Lumen Airway

Useful backup airway in instances where Endotracheal intubation attempts are unsuccessful. The greatest advantage is that they can be inserted no matter what position the patient is in.

Indications

- Basic Providers – the primary airway device for an unconscious trauma patient who lacks a gag reflex and is apneic or ventilating at a rate of less than 10/min.
- Advanced Providers – alternative airway device when the provide is unable to perform Endotracheal intubation and cannot easily ventilate the patient with a BVM device.

Contraindications

- Intact gag reflex
- Known esophageal disease
- Recent ingestions of caustic substances

Complications

- Gagging and vomiting, if gag reflex is intact
- Damage to the esophagus
- Hypoxia if ventilated using the wrong lumen

ENDOTRACHEAL INTUBATION **–** one of the most important and can have dramatic effect on trauma patient's outcome. Most desirable method for achieving maximum control of the airway in trauma patient who is either apneic or require assisted ventilation.

Advantages

- Isolates the airway
- Allow for ventilation with 100% oxygen
- Eliminates the need to maintain an adequate mask to face seal
- Significantly decreases the risk of aspiration
- Facilitates deep tracheal suctioning
- Prevents gastric insufflation
- Provides an additional route for medication administration

Indications

- Patient who is unable to protect his or her airway
- Patient with significant oxygenation problem requiring administration of high concentrations of oxygen
- Patient with significant ventilatory impairment requiring assisted ventilations

Contraindications

- Lack of training in technique
- Lack of proper indications
- Close proximity to receiving facility (relative contraindication)

Complications

- Hypoxemia from prolonged intubation attempts
- Trauma to the airway with resultant hemorrhage
- Right mainstem bronchus intubation
- Esophageal intubation
- Vomiting leading to aspiration
- Loose or broken teeth
- Injury to the vocal cords
- Conversion of a cervical spine injury without neurologic deficit to one with deficit.

Orotracheal Intubation

Requires the patient to be in the sniffing position and should not be used in the trauma patient with suspected cervical spine fracture.

Nasotracheal Intubation

If spontaneous ventilations are present, the provider may attempt blind nasotracheal intubation only if the benefit outweighs the risk. Extreme caution should be exercised when attempting in the presence of midface trauma or fractures.

Face to Face Intubation

Indicated when standard intubation techniques cannot be used because of the inability of the rescuer to assume the standard position at the head of the patient.

- Vehicle entrapment
- Pinning of the patient in rubble.

Pharmacoloigcally Assisted Intubation

Intubation using pharmacologic agents may occasionally be required to facilitate tube placement in the injured patient. The use of drugs to assist with intubation (RSI) is not without risk. Pharmacologically assisted intubation is a procedure of necessity, not convenience.

- *Intubation using sedatives or narcotics* – Medications such as diazepam, midazolam, Fentanyl or morphine are used alone or in combination with the goal being to relax the patient enough to permit intubation but not to abolish protective reflexes or breathing
- *Rapid sequence intubation (RSI) using paralytic agents* – The patient is chemically paralyzed after first being sedated. This provides complete muscle paralysis but removes all protective reflexes and cause apnea. Studies of this method of airway management have generally been positive with intubation success rates reported in the mid 90% range and with relatively few complications.

In every trauma patient for whom the prehospital provider considers pharmacologically assisted intubation, he or she must carefully weigh the benefits of securing an airway against the additional time spent on the scene to perform the procedure.

Indications

- Any person who requires a secure airway and is difficult to intubate because of uncooperative behavior (as induced by hypoxia, traumatic brain injury, hypotension or intoxication

Relative Contraindications

- Availability of an alternative airway
- Severe facial trauma that would impair or preclude successful intubation
- Neck deformity or swelling that complicates placement of a surgical airway
- Known allergies to indicated medications
- Medical problems that would preclude use of indicated medications
- Inability to intubate

Complications

- Inability to insert the Endotracheal tube in a sedated or paralyzed patient no longer able to protect his or her airway or breath spontaneously; required prolonged BVM until medication wears off
- Development of hypoxia or hypercarbia during prolonged intubation attempts
- Hypotension; virtually all of the drugs have a side effect of decreasing blood pressure. Patients who are mildly or moderately Hypovolemic may have a profound drop in blood pressure associated with medication administration.

Verification of Tube Placement

- Direct visualization of tube
- Presence of bilateral breath sounds
- Visualization of the chest rise
- Fogging (water condensation in the tube on expiration)

Adjunct Devices

- Esophageal detector device
- Carbon dioxide monitoring
- Colorimetric carbon dioxide detector
- End tidal carbon dioxide monitoring (capnography)
- Pulse oximetry

In pt. with a perfusing rhythm, capnography serves as the gold standard. Patients in arrest do not generate carbon dioxide and therefore neither colorimetric detectors nor capnography may be useful. Continued pulse oximetry should be considered necessary for any patient requiring intubation.

Retrograde Intubation

Potentially useful because the presence of blood or secretions does not hinder insertion as it may in more traditional intubation methods.

- A needle is inserted into the caudal aspect of the cricothyroid membrane. A guide wire is advanced through the needle into the oropharynx. An Endotracheal tube is then advanced over the guide wire into the oropharynx.
- Generally not recommended for use in apneic patients.

Indications
- Patients in whom Endotracheal intubation failed but for whom ventilation can be assisted wit a BVM.

Contraindications
- Apneic patient
- Close proximity to receiving facility
- Insufficient training

Complications
- Damage to the vocal cords and larynx
- Bleeding at the puncture site
- Esophageal intubation
- Hypoxia or hypercarbia during the procedure.

Digital Intubation

Essentially the intubator's fingers act in a fashion similar to a laryngoscope blade by manipulating the epiglottis and acting as a guide for the tube.

Indications:
- Patients in whom intubation failed but ventilations can be assisted with a BVM device
- Intubation equipment is in short supply or fails
- Airway is obscured or blocked by large volumes of blood or vomitus
- Entrapment with inability to perform face-to-face intubation.

Contraindications:
- Patient not comatose

Complications:
- Esophageal intubation
- Lacerations or crush injuries to the provider
- Hypoxia or hypercarbia during procedure
- Damage to the vocal cords

Laryngeal Mask Airway (LMA)

Alternative for unconscious adult and pediatric patients. The device consists of an inflatable ring attached to a silicone tube. The ring creates a low pressure seals between the LMA and the glottic opening without direct insertion into the larynx.

Advantages

- Blind insertion
- Can be used multiple times (Disposable now available)
- Available in a range of sizes for both adults and pediatrics

Indications
- Unable to perform intubation and the patient cannot be ventilated via BVM

Contraindications
- Endotracheal intubation can be performed
- Insufficient training

Complications
- Aspiration because it does not completely prevent regurgitation
- Laryngospasm

Percutaneous Transtracheal Ventilation

In rare instances, a trauma patients airway obstruction cannot be relieved by other methods.

Advantages
- Ease of access
- Ease of insertion
- Minimal equipment requirements
- No incision necessary
- Minimal education required

Indications
- All other alternative methods of airway management fail or are impractical

Contraindications
- Insufficient training
- Lack of proper equipment
- Ability to secure an airway by other means

Complications
- Hypercarbia from prolonged use
- Damage to surrounding structures

Surgical Cricothyrotomy

Creation of a surgical opening in the cricothyroid membrane, which lies between the larynx and the cricoid cartilage. This should be considered an airway of last resort.

Indications
- Massive midface trauma precluding the use of BVM
- Inability to control the airway using less invasive maneuvers
- Ongoing tracheobronchial hemorrhage

Contraindications
- Any patient who can be ventilated by less invasive method
- Patients with laryngotracheal injuries
- Children under 10 years
- Acute laryngeal disease of traumatic or infectious origin
- Insufficient training

Complications
- Prolonged procedure time
- Hemorrhage
- Aspiration
- Misplacement or false passage of ET tube
- Injury to neck structures or vessels
- Perforation of the esophagus

Ventilatory Devices

Masks – good fit: is equipped with a one way valve; is made of a transparent material; has an oxygen insufflation port and is available in infant , pediatric and adult sizes.

Bag Valve Masks – Most have volume of 1600ml and can delivery up to 90% concentration. A single provider attempting to ventilate with a BVM may create poor tidal volume because of difficulty sealing the mask with one hand.

Evaluation

Pulse Oximetry
- Allows provider to detect early pulmonary compromise or cardiovascular deterioration before physical signs are evident.
- High reliability, portability, ease of application

Measurements of arterial oxyhemoglovin saturation and pulse rate. Determined by measuring absorption ratio of red and infrared light passed through tissue. Normal SDp02 is between 93% and 95%. To ensure accuracy:
- Use appropriate size and type of sensor
- Proper alignment of sensor light
- Ensure that sources and photo detectors are clean
- Avoid sensor placement on grossly edematous sites

Common problems

- Excessive motion
- Moisture in sensor
- Improper sensor application and placement
- Poor patient perfusion or vasoconstriction from hypothermia
- Anemia

May be less than accurate in the critical trauma patient because of poor capillary perfusion status.

Capnography

Measures the partial pressure of carbon dioxide in a sample of gas. If this sample is taken at the end of exhalation it correlates closely with PaC02. In the critical patient the PaC02 is generally 2-5mmHg higher than ETC02. A normal reading is between 30-40mmHg.

Certain conditions cause variations in accuracy

- Severe hypotension
- High intrathoracic pressure
- Increase in dead space ventilation such as with pulmonary embolism

The provider should base initial transport decisions on physical en environmental conditions. He/She should not take the time to place the patient on monitors if the patient is losing blood.

CHAPTER FIVE
THORACIC TRAUMA

Chest injuries are a leading cause of trauma deaths (1 of 4). 90% of blunt injuries and 70-85% of penetrating injuries can be treated without surgery.

Anatomy

- Hollow cylinder composed of twelve pairs of ribs
- A nerve, an artery and a vein are located along the underside of each rib
- Intercostal muscles connect each rib to the one above – These are the primary muscles of ventilation along with the diaphragm.
- The parietal pleura lines the inner side of the thoracic cavity
- Visceral pleura covers the outer surface of each lung
- No space exists between the pleura however it is a potential space which can hold up to 3000ml of fluid
- Mediastinum is located in the middle of cavity. All other organs and structures including the heart, great vessels, trachea, mainstem bronchi and isophagus.

Although respiration and ventilation are frequently interchanged, they represent two distinct processes. Ventilation is the mechanical process and respiration is the biological process.

Neurochemical Control of Respiration

Respiratory center located in brainstem contains chemoreceptor cells that are sensitive to changes in certain chemical levels in the body. They stimulate nerve impulses that control inspiration. The chemical to which the respiratory center's chemoreceptor cells normally respond is C02.

Minute Volume = volume of air moved per breath x breaths/min

Minute volume becomes significant when the patient has an altered breathing patter.

Pathophysiology

Chest injuries can be either blunt or penetrating. *Penetrating* caused by forces distributed over a small area that actually penetrate into the chest cavity. Organs injured are those that lie along the path of the penetrating object. *Blunt*; the forces are distributed over a larger area, and injuries occur from compression and shearing forces.

Assessment

Signs and symptoms of chest trauma related to chest wall and lungs;
- Shortness of breath
- Tachypnea
- Chest pain (usually pleuritic)

Conditions such as pneumothorax, major vascular injuries or injuries to the esophagus may not produce initial symptoms. Examination of the chest includes the following:

1. **Observation** – an exam can be completed in 30 seconds. Observation of the neck and chest may reveal bruises, lacerations, distended neck veins, tracheal deviation, subcutaneous emphysema, open chest wounds, lack of symmetrical chest rise or paradoxical chest movement. Cyanosis is often a late sign of hypoxia.
2. **Palpation** – Neck and chest for presence of tenderness, bony crepitus, subcutaneous emphysema and an unstable chest wall segment.
3. **Ausculatation** – Lungs for presence or absence of breath sounds, the volume inspired, and bilateral symmetry of air movement.

Management of Specific Injuries

Rib Fractures – considerable force required to break ribs. 30**%** of fractures of the first and second ribs die from associated injuries. 5% have a ruptured aorta. Most common location is lateral aspect of ribs 3-8. Long thin and poorly protected.

Associated injuries include; pulmonary contusion, laceration of the intercostals artery an/or vein with resulting hemothorax, pneumothorax and hemorrhage; and hematoma formation in the chest wall or in the alveoli and surrounding tissue.

Assessment – simple rib fractures are rarely life threatening. Signs and symptoms include

- Pain with movement
- Local tenderness
- Perhaps bony crepitus

More important is assessment and recognition of associated injuries to underlying structures which may be life threatening.

Management – goal is pain reduction which is usually accomplished by splinting and minimizing movement of the fractured ribs. The effectiveness of ventilation should be evaluated. Normal ventilation and coughing should be encouraged despite associated pain. Prevents atelectasis which can lead to pneumonia. Should not be stabilized using tape or other firm bandaging or binding the encircles the chest and this will inhibit chest movement.

Flail Chest – usually caused by an impact into the sternum or the lateral side of the thoracic wall. Two or more adjacent ribs are each fractured in a at least two places. The segment has lost its bony support and attachment to the thoracic cage. Will move in the opposite direction from the rest of the chest during inspiration and expiration. The result is decreased ventilation.

Four consequences;

- Decrease in vital capacity proportional to the size of the flair segment.
- Increase in the labor of breathing
- Pain produced by the fractured ribs, limiting the amount of thoracic cage expansion
- Contusion of the lung beneath the flail segment.

Assessment – Tenderness and/or bony crepitus elicited by palpation should lead to a closer inspection for paradoxical motion. Initially intercostals muscle spasm may prevent significant paradoxical motion, but as these muscles tire it will become more obvious.

Management

- Supplemental oxygen
- Aggressive ventilatory support
- The key is to assist the patient's ventilatory efforts with positive pressure ventilation

A large percentage of patients with significant flail chest will progress to ventilatory failure and eventually require prolonged ventilatory support. The use of sand bags to prevent movement decreases aeration of the lungs and promotes aveolar collapse. **This method should no longer be used.**

Pulmonary Contusion – an area of the lung that has been traumatized to the point where interstitial and alveolar bleeding occur. The result is decreased oxygen transport across the thickened membranes. Hemorrhage into the alveolar sac prevents oxygenation of the affected segment. The mechanism of injury and the presence of associated injuries may be the only indications of a potential pulmonary contusion during the primary survey of the patient.

Management

Closely monitored with special attention to fluid administration. Any extra fluid will increase the amount of interstitial fluid and further decrease oxygen transport. Fluids should not be restricted in patients with evidence of compensated or Decompensated shock. The provider should provide oxygen to keep an oxygen saturation above 95%.

Simple Pneumothorax

Presence of air in the pleural space. The air separates the two pleural surfaces, causing the lung on the involved side to collapse as the separation expands. As air continues to accumulate and pressure in the pleural space increases, the size of the lung continues to decrease. The lung may partially or totally collapse.

The large reserve capacity of the ventilatory and circulatory systems usually prevent serious acute consequences from a simple pneumothorax in young and healthy patients.

Assessment

- Pleuritic chest pain
- Difficult and rapid breathing
- Decreased or absent breath sounds on the involved side
- Percussion for bell tympany is an excellent indicator (difficult to detect in the field)
- When lung collapse is partial the provide may hear reduced or absent breath sounds over the apices and bases of the lungs before there is any decrease over the midlung fields.

Management

- Assisted ventilation may be necessary for patients with a ventilatory rate of less than 12 or greater than 20 who display signs of hypoxia.
- Assisted ventilations may increase the possibility of a tension pneumothorax.
- If no indication for immobilization the patient should be transported semi-fowlers

Open Pneumothorax

Open chest wall injuries often the result of a gunshot or know wound. The severity of a chest wall defect is directly proportional to its size. Many small wounds will seal themselves.

Assessment

- Pain at injury site
- Shortness of breath
- Moist sucking or bubbling sound as air moves in and out of the pleural space through the defect

Management

- First priority is to close the hole
- Supply supplemental oxygen
- May require ventilation however keep in mind that positive pressure ventilation may quickly lead to a tension pneumothorax.
- If signs of increasing respiratory distress after closing with occlusive dressing, the dressing should be removed immediately to assist in decompressing the affected side.

Tension Pneumothorax

A one-way valve is created, allowing air to enter but not leave the pleural space. As the pressure exceeds the outside atmospheric pressure the lung, blood vessels and ventricle on the contralateral side are pressed. The result is that ventilation becomes increasingly difficult and the flow of venous blood into the heart decreases. This results in an overall decrease in cardiac output and shock ensues.

Assessment

Early Signs:
- Unilateral decreased or absent breath sounds
- Increased dyspnea and tachypnea despite treatment

Progressive Signs:
- Increasing tachypnea and dyspnea
- Tachycardia
- Subcutaneous emphysema
- Increasing difficulty ventilating an intubated patient.

Late Signs:
- JVD
- Tracheal deviation
- Tympany
- Signs of acute hypoxia
- Narrowing pulse pressure
- Signs of increasing Decompensated shock.

Treatment
- If associated with open chest wound; remove the dressing for a few seconds
- Reduce pressure in pleural space with needle decompression

Needle decompression or dressing removal is only a temporary solution until more definitive care can be provided. Indications for needle decompression are:
- Worsening respiratory distress or difficulty ventilating with BVM
- Decreased or absent breath sounds
- Decompensated shock (systolic BP <90mmHg)

The mid clavicular site is preferred, just over the top of the third rib. The anterior chest provides better visualization of the needle and often has less tissue to penetrate. Once the rush of air is noted, the needle should be advanced no further. Needle decompression will convert a life threatening tension pneumothorax into a non-life threatening open pneumothorax. The provider should not waste time with a one way valve. The open pneumothorax created by the needle will not significantly impair a patient's ventilatory effort.

Hemothorax

Blood in the pleural space. Each side of the thorax can hold 2500-3000ml of blood. The clinically critical component is blood loss.

Assessment

Directly related to blood loss and to a much lesser extent the amount of lung collapse and the resulting shortness of breath. Signs include tachypnea, decreased breath sounds and clinical signs of shock.

Management

- High concentration of oxygen
- Hypovolemia and shock are the major physiologic defects and should be treated with intravenous electrolyte solutions and rapid transport to an appropriate facility.

Blunt Cardiac Injury

The heart occupies a large portion of the center of the chest. The heart can be crushed between the sternum and spine. The most common injury is myocardial contusion. The ventricles can be forcefully compressed and systolic blood pressure can rise to 800mmHg causing compression of the myocardial wall. This can cause cell wall destruction, rupture of the wall or damage to the valves. The right ventricle is most common injured because of its location beneath the sternum. The clinical results are

- Disturbance in the electrical conduction system of the myocardium
- Valvular rupture
- Rupture of the myocardial wall which may lead to rapid exsanguination

Assessment

- Partial or full thickness contusions may be indicated by reduced cardiac output and dysrhythmias; however signs of these contusions may not be evident at all.
- Mechanism of injury (bent steering wheel)
- Do not usually exhibit symptoms but may have complaint of chest pain or pain of fractured ribs or bruised muscles.
- PVC's or atrial fibrillation.
- ST elevation on EKG

Management

- High flow oxygen – monitoring the patients pulse
- Treat any arrhythmias pharmacologically

Pericardial Tamponade

The heart is enclosed within a tough, fibrous, flexible but inelastic membrane called the pericardium. It is a potential space. Blood can enter the pericardial space if myocardial blood vessels are torn by blunt or penetrating trauma. This condition, called hemopericardium can lead to pericardial Tamponade.

Most frequently associated with stab wounds. Gunshot wounds create a large enough hole for blood to exit the pericardial space. As pressure builds it compresses the heart and does not allow it to fully expand or refill with blood. This reduces cardiac output and decreases perfusion.

Assessment

- May lack symptoms other than those related to chest injuries and associated shock
- 200-300ml of blood before tamponade will occur, although small volumes can still significantly reduce cardiac output.
- Tachycardia: Pulse pressure narrows
- Paradoxical pulse may be present (the systolic BP drops for than 10-15mmHg during each inspiration) can be determined clinically by noting that the radial pulse diminishes or even disappears with inspiration.\JVD
- Heart sounds muffled and distant
- Signs of shock appear and progressively worsen

<u>Becks Triad – </u>Elevated venous pressure, shock and muffled heart sounds.

Management

- Require rapid, well monitored transport to appropriate facility
- IV electrolyte infusion may improve cardiac output by incr4easing venous pressure
- Needle Pericardiocentesis – limited to the emergency department is a temporary intervention until control of bleeding and surgical repair of the injury can occur.

Aortic Rupture

Usually results from a shear injury. The heart and aortic arch suddenly move either anteriorly or laterally. The heart and arch move away from the descending aorta, which is tightly fixed to the thoracic vertebrae. The two components can be torn apart. 80-90% of pts with this injury sustain immediately rupture and complete exsanguination in the left pleural space within the first hour. One third of the initial survivors die within 6 hours and another third die within 24 hours.

Assessment

- Difficult diagnosis
- Information from the scene concerning the magnitude of the trauma can be helpful
- Unexplained shock with a frontal impact deceleration injury or lateral impact acceleration injury must suspect aortic disruption.
- Difference between pulse quality in the arms and the lower torso or between the left and right arms

Management

- Oxygenation
- Immediate transport

Tracheal/Bronchial Rupture

These tears allow rapid movement of air into the pleural space, producing a tension pneumothorax. Rather than a simple one time rush of air from needle decompression, air continually flows from the needle. Assisted ventilation frequently worsens the condition of the patient.

Assessment

- Severe dyspnea
- Cough up bright red blood

Management

- Assisted ventilations may be extremely difficult
- If this makes the patient worse the provider should allow the patient to breath spontaneously with supplemental oxygen
- Rapid Transport

Traumatic Asphyxia

The patient looks like victims of strangulation, but the condition has nothing to do with asphyxia. With severe blunt and crushing injuries to the chest and abdomen a marked increase in intrathoracic pressure occurs. This forces blood backward out the right side of the heart and into the veins of the upper chest and neck.

Assessment

- Bluish discoloration to the face and upper neck
- The skin below this area is pink
- JVD and swelling or hemorrhage of the conjunctiva may be present

Management

- Because of the forces involved, any of the other injuries of the chest may be present
- Identifying the condition
- Providing airway maintenance
- Managing associated injuries

Disphragmatic Rupture

Forceful compression to the abdomen, intra-abdominal pressure may increase enough to tear the diaphragm and allow abdominal contents to enter the thoracic cavity. The space occupied by these organs restricts lung expansion and reduces ventilation.

Lacerations of the diaphragm can also occur in penetrating trauma because of the change in position of the diaphragm with ventilation.

Assessment

- Extremely difficult condition to diagnose
- Shortness of breath
- Decreased breath sounds particularly over the left chest
- Bowel sounds may be heard in the left chest

Management

- Positive pressure ventilation
- Rupture can worsen with anything that increases intraabdominal pressure such as MAST
- Diaphragmatic rupture is one of the few situations in which field deflation of the MAST is indicated.

CHAPTER 6
SHOCK AND FLUID RESUSCITATION

The correct definition of shock is a widespread lack of tissue perfusion with oxygenated red blood cells that leads to anaerobic metabolism and decreased energy production. Although providers can delay death for several hours to several days or weeks, the most common cause of that death is insufficient early resuscitation.

Anatomy and Physiology

For metabolism to produce energy, cells must have fuel (oxygen and glucose.) In the body, oxygen and glucose are mixed to produce energy. The by products are carbon dioxide and water. **Aerobic metabolism** is the process for energy production in the human body using oxygen. **Anaerobic metabolism** is when energy is produced without oxygen. Aerobic metabolism is the body's normal combustion process. It produces energy using oxygen through a series of chemical reactions known as the Krebs cycle. The energy that is produced is ATP. Anaerobic metabolism is inefficient at producing ATP and produces by products (lactic acid and pyruvic acid) which can cause problems when they accumulate.

Depending on the organ initially involved, the progression from cell death to organism death can be rapid or delayed. It can take as long as several days to several weeks for trauma related hypoxia or hypoperfusion to result in a patient's death.

The sensitivity of the body's cells to the lack of oxygen varies from organ system to organ system. This sensitivity is called **ischemic sensitivity** and is the greatest in the brain and heart (4-6 minutes) and longest in the skin and muscle tissue (6-8 hours).

Fick Principle

Description of the components necessary for adequate oxygenation of the body cells.

1. On loading of oxygen to RBC's in the lungs. This requires that the patient's airway be patient, that ventilation is of adequate volume, depth and rate and that the percentage of oxygen in the inspired air is adequate. Adequate diffusion across the aveolar membrane in the lung must occur. This may be impaired by pulmonary contusions, pneumothorax, pulmonary edema, aspiration and airway obstruction.
2. Delivery of RBC's to tissue cells. Requires a sufficient number of RBC's and adequate blood volume. Anything that affects these two factors can severely impair perfusion.
3. Off loading of oxygen from RBC's to tissue cells. The most common problem with off loading occurs when edema separates the RBC's from the capillaries. Carbon monoxide impairs the ability of the hemoglobin molecule to release oxygen in the body's tissues.

Prehospital treatment of shock is directed at maintaining the critical components of adequate oxygenation. The goal is to deliver adequate oxygen to produce enough energy to prevent or reverse anaerobic metabolism. The most important focus in prehospital is:

1. Delivering sufficient amount of oxygen to the alveoli, including airway management, the use of supplemental oxygen and assisted ventilation
2. Controlling external hemorrhage, recognizing the presence of internal hemorrhage, providing external compression, restoring circulatory volume and providing rapid transport to the appropriate facility.
3. Recognizing the potential for toxic inhalations.

Cardiovascular System

Consists of a pump (heart), the vascular system (a container and complex branching pipeline consisting of arteries, veins, and capillaries through which the blood travels) and the circulating fluid (blood).

Cardiac output is reported in liters/min. It is not measured in the prehospital environment, however understanding cardiac output and its relationship to stroke volume is important in understanding shock management.

An adequate amount of blood must be present in the vena cava and pulmonary veins to fill the ventricles. Starling's law of the heart is an important concept explaining how this relationship works. - - the more the ventricles fill, the greater the strength of contraction.

The resistance to blood flow that the left ventricle must overcome to pump blood is called **afterload.** It is a function of systemic vascular resistance. As peripheral arterial vasoconstriction increases, the heart has to generate a greater force to pump blood into the artery system. Widespread vasodilation decreases afterload.

Blood vessels contain the blood and route it to the various areas and cells of the body. Blood contains not only RBC;s but also infection fighting factors and antibodies, platelets; essential for clotting ,protein for cellular rebuilding, glucose and other substances necessary for metabolism and survival.

One way the body maintains balance is by shifting water from one space to another. **Diffusion** is the movement of solutes across a membrane., Solutes attempt to move from areas in which they are more numerous to areas in which they are less concentrated as part of the homeostatic drive.

Osmosis is the movement of water across a membrane from an area that is hypotonic (low solute concentration) to an area that is hypertonic (high solute concentration.) By diluting the solute concentration on the hypertonic side of the membrane, this movement of water brings both sides to equal solute concentrations.

Nervous system

Directs and controls the involuntary functions of the body, such as respiration, digestion and cardiovascular function. Divided into the sympathetic and parasympathetic nervous systems. They frequently work against each other to keep vital body systems in balance.

Sympathetic produces the fight flight response. Simultaneously causes the heart to beat faster and stronger, increases the ventilatory rate and constricts the blood vessels to nonessential organs, while dilating vessels and improving blood flow to the muscles.

Parasympathetic system provides control. The vagal response of the parasympathetic system slows the heart rate and reduces the force of contractions, maintaining the body in balance.

The medulla is the primary regulatory center of autonomic control of the cardiovascular system.

Using these systems the body can compensate for loss of up to 30% of blood volume without becoming hypotensive. Thus **hypotension is a late finding of shock and indicates the body's compensatory mechanisms have already failed.**

The Cardiovascular System in Shock

1. The blood supply to the heart, brain and lungs receives the highest priority. The body strives to maintain this part at all costs because its failure would deprive the entire body of circulating oxygenated blood.
2. The blood supply to the liver and kidneys receives the next highest priority.
3. The blood supply to the skin and soft tissues of the extremities and the gastrointestinal tract receives the lowest priority.

Blood is shunted away from the lower priority areas to those areas that are more sensitive to the loss of oxygenated blood and are essential to maintain life.

Decreased or absent blood flow will occur on the distal side of the increased vascular resistance. The decreased circulation through the distal capillary beds and decreased blood flow through distal arteries translate into three of the common signs of shock:

- Loss of normal skin color and temperature
- Absent or thready distal pulse
- Delayed capillary refilling time

The pathophysiologic process of shock can be theoretically divided into three stages.

1. The *ischemic phase* is characterized by reduction of capillary blood flow and conversion to anaerobic metabolism with production of toxic by products.
2. In the *stagnant phase*, precapillary sphincters open but postcapillary sphincters remain closed. This results in an increase in hydrostatic pressure within the capillaries. The increased pressure forces fluid out of the capillaries into the interstitial space, contributing to tissue edema.
3. When the post capillary sphincters open, the *washout phase* begins. The accumulation of toxic by products from the first two phases is washed out into the systemic circulation during this third stage. What was once a contained, localized acidosis now becomes a system acidosis.

The result of shock is that the heart is forced to function with three handicaps, all of which decrease it efficiency:

1. Increased afterload
2. Decreased oxygenation
3. Lack of available fluid to fill the ventricles during diastole

Trauma that results in severe hypoxia and shock also stimulates the body's inflammatory system, further aggravating the underlying condition. If large amounts of edema is present, the distance between the capillary wall and cell membrane becomes much greater. Oxygen must diffuse through the capillary wall, then through the interstitial fluid, and finally through the cell membrane.

CAUSES AND TYPES OF SHOCK

HYPOVOLEMIC SHOCK

When acute blood volume loss occurs through dehydration or hemorrhage, the relationship of fluid volume to the size of the container becomes unbalanced. The container retains its normal size, but the fluid volume is decreased. Hypovolemic shock is the most common cause of shock encountered in the prehospital environment and blood loss is by far the most common cause of shock in the management of trauma patients.

Hemorrhagic shock can be categorized into four classes depending on the severity of the hemorrhage.

1. *Class I hemorrhage* represents a loss of up to 15% of blood volume. Few clinical manifestations. Tachycardia is minimal and no change in blood pressure, pulse pressure or ventilatory rate. Usually do not require fluid resuscitation.
2. *Class II Hemorrhage* represent a loss of 15% to 30% of volume. Most adults are capable of compensating for this amount by activation of the sympathetic nervous system. Clinical findings include increased respiratory rate, tachycardia and a narrowed pulse pressure. The patient often demonstrates anxiety or fright. Urinary output drops slightly to between 20-30ml/hr in the adult. These patients usually respond well to crystalloid infusion.

3. *Class III Hemorrhage* represents a loss of 30% to 40% of blood volume. When blood loss reaches this point most patients are no longer able to compensate for the volume loss of hypotension occurs. The classic findings of shock are obvious and include tachycardia, tachypnea and severe anxiety or confusion. Urinary output falls to 5-15ml/hr. Many oaf these patients require blood transfusion for adequate resuscitation.
4. *Class IV Hemorrhage* represents a loss of over 40% of blood volume. This stage of severe shock is characterized by marked tachycardia (>140/min), tachypnea (>35), profound confusion or lethargy and a markedly decreased systolic blood pressure typically in the range of 60mmHg. These patients truly have only minutes to live. Survival depends on immediate control of hemorrhage (surgical) and aggressive resuscitation including blood transfusions.

The definitive management for volume failure is to replace the lost fluid. Because blood replacement is usually not available in the prehospital environment, trauma patients who have lost blood should undergo measures to control blood loss and receive an IV electrolyte solution and rapid transportation to the hospital.

Replacement ratio with electrolyte solutions should be 3 liters of replacement for each liter of blood lost. The best crystalloid solution for treating hemorrhagic shock is lactated Ringers solution. NSS is another crystalloid solution that can be used for volume replacement but its use may produce hyperchloremia.

A pneumatic antishock garment may provide short term assistance with managing severe hemorrhagic shock by increasing vascular resistance, reducing container size, and tamponading abdominal and pelvic hemorrhage. The most important use of MAST is in intraabdominal and pelvic hemorrhage control in patients with a blood pressure below 60mmHg.

Distributive Shock

Occurs when the vascular container enlarges without a proportional increase in fluid volume. In distributive shock, resistance to flow is decreased because of the relatively large size of the blood vessels. This reduced resistance decreases the diastolic blood pressure. When this reduced resistance is combined with the reduced preload and therefore a reduced cardiac output, the net result is a decrease in both systolic and diastolic blood pressure.

Neurogenic Shock

Occurs when a cervical spine injury damages the spinal cord above the nerves of the sympathetic system. Because of the loss of sympathetic control of the vascular system, which controls the smooth muscles in the walls of the blood vessels, the peripheral vessels dilate below the level of the injury. The patient is not Hypovolemic, but the normal blood volume insufficiently fills an expanded container. Thus decrease in blood pressure does not compromise energy production and therefore is not shock.

Decompensated Hypovolemic shock and neurogenic shock both produce a decreased systolic blood pressure. The other vital signs vary significantly and the treatment for each is also different. Neurogenic shock displays decreased systolic and diastolic pressures, but the pulse pressure remains normal. The patient has warm, dry skin, especially below the area of injury. Bradycardia is typically seen rather than tachycardia but the pulse quality may be week. Hypovolemia produces a decreased LOC or at least anxiety and often combativeness. In the absence of traumatic brain injury, the neurogenic shock patient is alert, oriented and lucid but has no reflexes.

Septic Shock

Seen in patients with life threatening infections. Preload is diminished because of vasodilation and loss of fluid and hypotension occurs when the heart can no longer compensate.

Psychogenic Shock

Mediated via the parasympathetic nervous system. Stimulation of the vagal nerve produces bradycardia and peripheral vasodilation and hypotension. The cardiac output falls dramatically resulting in insufficient blood flow to the brain. Vasovagal syncope occurs. Compared with neurogenic shock, the periods of bradycardia and vasdodilation are generally limited to minutes, whereas neurogenic shock may last up to several days.

Cardiogenic Shock

Results from causes that can be categorized as either a result of direct damage to the heart or related to a problem outside the heart.

Intrinsic Causes

- Heart Muscle Damage
- Dysrhythmia
- Valvular Disruption

Extrinsic Causes

- Pericardial Tamponade
- Tension Pneumothorax

Complications of Shock

Prehospital care providers fail to realize that the quality of care delivered in the field can alter a patient's hospital coursed and outcome. Failure to recognize shock and initiate proper treatment in the field may extend the patient's hospital length of stay.

Acute Respiratory Distress Syndrome

Is the result of damage to the lining of the capillaries in the lung, leading to the leakage of fluid into the interstitial spaces and alveoli. This makes it much more difficult for oxygen to diffuse across the alveolar walls and into the capillaries and bind with the RBC's. ARDS represents noncardiogenic pulmonary edema and patients generally do not improve with diuretic therapy.

Acute Renal Failure

Impaired circulation to the kidneys resulting from inappropriate care of shock leading to prolonged shock can lead to temporary or permanent renal failure.

Hematologic Failure

The term coagulopathy refers to impairment in the normal blood clotting capabilities. This may result from either hypothermia, reduced energy production to these cells or depletion of the clotting substances as they are used in an effort to control bleeding.

Hepatic Failure

Severe damage to the liver is a less common result of prolonged shock.

Multiple Organ Failure

Failure of one major body system is associated with a mortality rate of about 40%. As an organ system fails, the shock state is further worsened. By the time four organ systems fail, the mortality rate is essentially 100%.

Assessment

Assessing a patient for shock requires checking individual systems or organs to identify the presence of shock.

The primary survey is a gross qualitative estimate of as many organs and systems as possible. The goal is to find any abnormalities that might suggest the presence of anaerobic metabolism. Simultaneous evaluation is an important part of patient assessment. This evaluation may not be done at a conscious level, but the prehospital care providers brain nonetheless continues to gather and process information.

The following signs identify the need for continued suspicious of life threatening conditions:

- Mild anxiety, progressing to confusion or altered LOC
- Mild tachypnea, leading to rapid, labored ventilations
- Mild tachycardis, progressing to a marked tachycardia
- Weakened radial pulse, progressing to an absent radial pulse
- Pale or cyanotic skin color
- Capillary refilling time greater than two seconds

Breathing

Tachypnea is frequently one of the earliest signs of shock. A rate of 20 to 30/min indicates a borderline abnormal rate and the need for supplemental oxygen. A rate greater than 30 indicates a late stage of shock and the need for assisted ventilation because it is generally associated with a decreased tidal volume.

Circulation

Two components: hemorrhage and perfusion. Assessment of circulation should begin with external bleeding. Next the patient's LOC should be assessed. The next important step is evaluation of the pulse to determine whether it is palpable at the artery being examined. In general, loss of a radial pulse indicates severe Hypovolemia or vascular damage to the arm, especially when a central pulse, such as the carotid or femoral is weak, thready and extremely fast.

The normal pulse rate is 60-100. A pulse of 100-120 identifies a patient who has early shock with an initial cardiac response toward tachycardia. A pulse above 120 is a definite sign of shock unless it is due to pain or fear and one over 140 is considered extremely critical and near death.

Skin Color

Pink skin color indicates a well oxygenated patient without anaerobic metabolism. Cyanotic or mottled skin indicates unoxygenated hemoglobin and a lack of adequate oxygenation usually resulting from one of three causes:

1. Peripheral vasoconstriction (most often associated with Hypovolemia)
2. Decreased supply of RBC's (acute anemia)
3. Interruption of blood supply to that portion of the body, such as might be found with a fracture

As the body shunts blood away from the skin to more important parts of the body, skin temperature decreases.

Capillary Refilling Time

The ability of the cardiovascular system to refill the capillaries after the blood has been removed represents an important support system. Evaluation of the nail bed of the big toe or thumb provides the earliest possible indication that hypoperfusion is developing.

Capillary refilling time has recently been described as a poor test of shock. However, it is not a test of shock, but rather a test of perfusion of the capillary bed being analyzed. One of the better signs of adequate resuscitation may be a warm, dry, pink toe.

Blood Pressure

One of the lease sensitive signs of shock. Blood pressure does not begin to drop until a patient is profoundly Hypovolemic from either true fluid loss of container enlarge relative Hypovolemia. When the patient's blood pressure begins to drop, an extremely critical situation exists and rapid intervention is required. Intervention varies based on the cause of the condition. For example, low blood pressure associated with neurogenic shock is not nearly as critical as low blood pressure with Hypovolemic shock. One important pitfall to avoid is to equate systolic blood pressure with cardiac output and tissue perfusion.

Disability

One system that can be readily evaluated in the field is brain function. At least 5 conditions can produce an altered LOC:

1. Hypoxia
2. Shock with impaired cerebral perfusion
3. Traumatic brain injury
4. Intoxication with alcohol or drugs
5. Metabolic processes such as diabetes, seizures or eclampsia

Of the five, the easiest to treat and the one that will kill the patient the most quickly if not treated is hypoxia.

Anxiety and belligerent behavior are usually the first signs, followed by a slowing of the thought processes and a decrease of the body's motor and sensory functions. The level of cerebral function is an important and measurable sign of shock.

A belligerent, combative, anxious patient or one with a decreased LOC should be assumed to have a hypoxic, hypoperfused brain until another cause can be identified.

Musculoskeletal Injuries

Significant internal hemorrhage can occur with fractures especially the femur and pelvis.

Confounding Factures

Age

Patients at extremes of life, the very young and the elderly have a diminished capability to compensate for acute blood loss and other shock states. A relatively minor injury may produce Decompensated shock in these individuals.

Athletic Status

Well-conditioned athletes often have enhanced compensatory capabilities. Many have resting heart rates in the range of 40-50. Thus a heart rate of 100-110 or hypotension in a well-conditioned patient may be a warning sign that indicates significant blood loss.

Pregnancy

A women's blood volume increases by up to 48%. Heart rate and cardiac output during pregnancy are also increased. A pregnant female may not demonstrate signs of shock until her blood loss exceeds 30-35%. During the third trimester the gravid uterus may compress the inferior vena cava, greatly diminishing venous return and resulting in hypotension. Elevation of the patient's left side once she has been immobilized to a long backboard may alleviate this. Hypotension in a pregnant female that persists after performing this maneuver typically represents life threatening blood loss.

Pre-existing Medical Conditions

Patients with serious preexisting conditions such and coronary artery disease and COPD are typically less able to compensate for blood loss and shock.

Medications

May interfere with the body's compensatory mechanisms. Beta blockade and calcium channel blocking agents used to treat hypertension may prevent an individual from developing a compensatory tachycardia that may maintain his or her blood pressure.

Management

Directed toward changing the anaerobic metabolism back to aerobic metabolism.

- Improve oxygenation of RBCs in the lungs through appropriate airway management
- Provide ventilatory support with a BVM and deliver a high concentration of oxygen
- Improve circulation to better deliver the oxygenated RBCs to the systemic tissues and improve oxygenation at the cellular level

- Reach definitive care as soon as possible for hemorrhage control and replacement of lost RBCs

Four questions should be asked when deciding what treatment to provide for a patient in shock:

- What is the cause of the patient's shock?
- What is the definitive care for the patient's shock?
- Where can the patient best receive this definitive care?
- What interim steps can be taken to manage the patient's condition while he or she is being transported to definitive care?

Airway

Patients in need of immediate management of thie rairway include the following in order of importance:

1. Those who are not breathing
2. Those who have obvious airway compromise
3. Those who have ventilatory rates in excess of 20/min
4. Those who have noisy sounds of ventilation

Pulse oximetry should be monitored in virtually all trauma patients. Oxygen should be titrated to maintain an Sp02 of at least 95%.

Circulation

Controlling external hemorrhage is the next priority.

1. Apply direct pressure over the bleeding site with a sterile dressing if available.
2. Continue direct pressure with elevation if an extremity is involved and no fracture is present
3. Apply direct pressure with elevation and use of a pressure point
4. Apply a tourniquet. This is used only in the direst circumstances or in some combat situations to control external bleeding from the extremities.

Applying direct pressure to exsanguinating hemorrhage takes precedence over insertion of intravenous lines and fluid resuscitation.

Internal bleeding from fracture sites should also be considered. Rough handling of an injured extremity may not only convert a closed fracture to an open one but it may also significantly increase internal bleeding from bone ends, adjacent muscle tissue or damaged vessels.

Patient Positioning

Trauma patient who are in shock should be transported in a supine position, immobilized to a long backboard. The Trendelenburg or "shock" position is no longer recommended. It may aggravate already impaired ventilatory function by placing the weight of the abdominal organs on the diaphragm and may increase intracranial pressure in patients with traumatic brain injury.

Expose/Environment

The patient's body temperature should be maintained within the normal range. Hypothermia produces myocardial dysfunction. Coagulopathy, Hyperkalemia, vasoconstriction and a host of other problems that negatively affect a patient's chance of survival.

Patient Transport

Two things that a patient in shock needs are blood transfusions and surgery. Since neither are available in the field, rapid transportation to a facility that is capable of managing the patient's injuries is extremely important. Rapid transportation does not mean disregarding or neglecting the treatment modalities that are important in patient care.

Pneumatic Antishock Garment (PASG, MAST)

Remains one of the most controversial devices every introduced to prehospital care. Pressure applied by the PASG to the legs and abdomen is transmitted directly through the skin, fat and muscle to the blood vessels themselves. As the vessels are compressed, their diameters are reduced in size. The result is increased SVR and thereby increased systolic and diastolic pressure. Venous return is increased, resulting in increased cardiac output.

Indications:

1. Suspected pelvic fractures with hypotension (systolic <90)
2. Profound hypotension
3. Suspected intraperitoneal hemorrhage with hypotension
4. Suspected retroperitoneal hemorrhage with hypotension

The PASG is probably significantly less effective than direct pressure or a pressure dressing with gauze and an elastic bandage for control of external bleeding of the lower extremities.

Contraindications

1. Penetrating thoracic trauma
2. Splinting of the lower extremities
3. Eviseration of abdominal organs
4. Impaled objects in the abdomen
5. Pregnancy
6. Traumatic cardiopulmonary arrest

Deflation

Prehospital deflation of the PASG should not be done except in extreme circumstances such as evidence of a ruptured diaphragm.

Volume Resuscitation

Volume Access

IV access should be obtained after the patient has been placed in the ambulance and transportation has been initiated to the closest appropriate facility. No research has even demonstrated improved survival of critically injured trauma patients when IV fluid therapy has been administered in the prehospital setting. Therefore transport of the trauma patient should never be delayed to initiate IV lines.

IV's should be started with two large bore catheters (short). The rate of fluid administration is directly proportional to the fourth power of the radius of the catheter and inversely proportional to it length. The preferred site is the veins of the forearm. Alternative sites include antecubital, hand and upper arm.

IV Solutions

Because of its ability to carry oxygen blood remains the fluid of choice for resuscitation. Because it is not usually carried in the field there are four alternative solutions for volume expansion.

1. Isotonic crystalloids
2. Hypertonic crystalloids
3. Synthetic colloids
4. Blood substitutes

Lactated Ringers remains the isotonic crystalloid solution of choice because its composition is most similar to the electrolyte composition of plasma. A rule of thumb is that most patients with hemorrhage generally only achieve adequate resuscitation when about 300cc of crystalloid solution has been infused for every 100cc blood loss.

Chapter Seven
Abdominal Trauma

Anatomy

The abdomen contains the major organs of the digestive, endocrine and urogenital systems and major vessels of the circulatory system. The surface of the abdomen is divided into four quadrants. The RUQ includes the liver and gallbladder, the LUQ contains the spleen and stomach and RLQ and LLQ contain primarily the intestines. The urinary bladder is midline between the lower quadrants.

Increased intraabdominal pressure produced by compression, such as being forced against a steering column, can rupture the abdominal cavity upward through the diaphragm, much like the compression of paper bag.

When injured solid organs (liver, spleen, aorta, vena cava) bleed, hollow organs spill their contents into the peritoneal cavity or retroperitoneal space. This results in peritonitis, sepsis and intraabdominal bleeding.

Injuries to the abdomen can be either penetrating or blunt. Penetrating trauma such as a gunshot or stab wound is more readily visible. A mental visualization of the trajectory of the missile or path of a knife blade can help identify possible injured organs.

Patients with penetrating injury to the thorax below the 6th intercostal space laterally and 8th intercostals space posteriorly may also have an abdominal injury. Penetrating wounds of the flanks and buttocks may involve organs in the abdomen as well.

Blunt injuries to intraabdominal organs are generally the result of compression or shear forces. Loss of blood into the abdominal cavity, regardless of its source can contribute to or be the primary cause of the development of shock.

Assessment

The index of suspicion for injury should be based on the mechanism of injury and physical findings, such as ecchymosis or marks of collision. Many patients with significant bleeding often do not display these signs. The most reliable indicator of intraabdominal bleeding is the presence of shock from an unexplained source.

The adult abdominal cavity can hold up to 1.5 liters of fluid before showing distension. The following are reliable indicators for establishing the index of suspicion for abdominal injury.

- Mechanism of injury
- Outward signs of trauma
- Shock with unexplained cause
- Level of shock greater than explained by other injuries

- Presence of abdominal rigidity, guarding or distension (a rare finding)

The assessment should include:

- **Inspection** – should be exposed and observed for distension, contusions, abrasions, penetration, evisceration, impaled objects and or obvious bleeding
- **Palpation** – can revel abdominal wall defects or elicit pain in the area. Voluntary or involuntary guarding, rigidity and/or rebound tenderness may indicate bruising, inflammation or bleeding. Deep palpation of an injured abdomen should be avoided as it can increase an existing hemorrhage.

Auscultation of bowel sounds is not helpful as a prehospital assessment tool.

Management

1. Rapidly evaluate the scene and the patient. After ensuring scene safety, attend to any life threats identified in the primary survey
2. Initiate treatment for shock, including high concentration oxygen
3. Apply MAST to reduce suspected intraperitoneal or retroperitoneal and if indicated to counter profound shock,.
4. Rapidly package and transport the patient to the nearest appropriate facility.
5. Initiate crystalloid intravenous fluid replacement enroute to the hospital.

Surgical intervention remains a key need, time should not be wasted in attempts to determine the exact details of injury.

Impaled Objects

Because removal of an impaled object may cause severe additional trauma and because the object's distal end may be controlling bleeding, removal of an impaled object is contraindicated. If bleeding occurs around it, direct pressure should be applied with the flat of the hand.

Psychological support of the patient is crucial, especially if the impaled object is visible to the patient.

The abdomen should not be palpated in these cases because palpation may produce additional tearing or intrusion by the distal end of the object.

Evisceration

The tissue most often visualized is the fatty ommentum that lies over the intestines. Protecting the protruding section of intestine or other organ from further damage presents a special problem. Attempts should not be made to replace the protruding tissue back into the abdominal cavity. Abdominal contents should be covered with sterile gauze, moistened with sterile saline.

CHAPTER EIGHT
HEAD TRAUMA

Anatomy

The scalp is the outermost covering of the head and offers some protection to the skull and brain. The scalp is highly vascular and seemingly minor wounds can produce significant hemorrhage. Uncontrolled hemorrhage from a complex scalp laceration can lead to Hypovolemic shock.

The skull is composed of a number of bones that fuse into a single structure during childhood. The skull provides significant protection to the brain, but the interior surface is rough and irregular. When exposed to a blunt force, the brain may slide across the irregularities, producing cerebral contusions or lacerations.

The Meninges cover the brain.

1. Dura Mata – the outermost layer is composed of tough fibrous tissue and lines the cranial vault. The middle meningeal arterial are located between the cranium and the dura mater in the epidural space. The dura mater closely adheres to the inner surface of the vault. However a blow to this area of think bone may produce a skull fracture that damages the artery, allowing blood to collect in this potential space. This injury is know as an *epidural hematoma.*
2. Pia Mater is a thin layer that closely adheres to the cortex of the brain. Below this layer is the subarachnoid space which is filled with CSF. Blunt trauma to the head that damages some of the veins between the brain and sagittal sinus can lead to a subdural hematoma.

The brain has the ability to autoregulate the amount of blood flow it receives when physiologic stresses are encountered. Cerebral blood flow remains remarkably constant with modest alterations in blood pressure; however it begins to decrease when the mean arterial pressure falls below 60mmHg.

Traumatic Brain Injury (TBI) can be divided into two categories;

1. Primary Brain Injury – direct trauma to the brain and associated vascular injuries that sustain severe damage as a direct result of the initial assault.
2. Secondary Brain Injury – an extension of the magnitude of the primary brain injury by factors that result in a large, more permanent neurologic deficit.
    a. Systemic factors that may lead to secondary brain injury can often be identified and treated in the prehospital setting. They include hypoxia, hypercapnia, hypocapnia, anemia, hypotension, hyperglycemia and hypoglycemia
    b. With the exception of seizures, intracranial causes of secondary brain injury can only be suspected and cannot be identified in the field. They include cerebral edema and intracranial hematomas.

Systemic Causes

The neurons of the central nervous system depend on a constant supply of oxygen. Confusion is often the earliest warning signal that cerebral oxygen delivery is impaired. Ischemic brain tissue may subsequently die if even brief periods of hypoxia complicate the primary injury. Irreversible brain damage can occur with only 4-6 minutes of cerebral anoxia.

Anemia and Hypotension

Patients with severe brain injury may sustain external and internal hemorrhage from accompanying injuries. If significant blood loss occurs, the resultant anemia can dramatically impair systemic oxygen deliver and may irreversible damage brain tissue. Hypotension may be a direct result of severe brain injury and almost always occurs shortly before death.

Hypoglycemia and Hyperglycemia

Both elevations and decreases in blood sugar can jeopardize ischemic brain tissue. Neurons are unable to store sugar and require a continual supply of glucose to carry out cellular metabolism. In the absence of glucose, ischemic neurons can be permanently damaged.

Intracranial Causes

Seizures

A patient with acute TBI is at risk for seizures. Hypoxia from either airway or breathing problems can induce generalized seizure activity, as can hypoglycemia and electrolyte abnormalities. Seizures in turn can aggravate preexisting hypoxia caused by impairment of respiratory function.

Cerebral Edema and Intracranial Hematomas

Cerebral edema often occurs at the site of primary brain injury. As cerebral edema increases, a dangerous cycle may be established in which the swelling further impairs oxygen delivery and compromises surrounding ischemic tissue resulting in more edema.

Intracranial hematomas are potentially life threatening because they occupy precious space without the skull. In addition to alterations in consciousness, these problems may produce changes in papillary function.

A dilated, slowing reactive (sluggish) pupil typically indicates compression on the 3rd cranial nerve as it cross the tentorial incisura. A dilated nonreactive (blown) pupil suggests uncal herniation on the same side as the abnormal pupil.

Intracranial Hypertension

Increased ICP significantly impairs cerebral function. *Cushings Phenomenon* refers to the ominous combination of marked increased arterial blood pressure and the result bradycardia that can occur with severely increased ICP.

Intracranial hypertension often produces abnormal ventilatory patterns or apnea that further worsen hypoxia and significantly alter blood carbon dioxide levels. Cheyne-Stokes or Central neurogenic Hyperventilation.

Abnormal motor posturing accompanies increased ICP. Decorticate posturing involves flexion of the upper extremities and rigidity and extension of the lower extremities. A more ominous finding is decerebrate posturing wherein all extremities are extended and arching of the spine may occur. After herniation, the extremities become flaccid and motor activity is absent.

Assessment

1. Breathing – respiratory function assessment must include rate, depth and adequacy of breathing. Pulse oximetry and end-tidal C02 monitors should be used.
2. Circulation – should note and quantify evidence of external bleeding.
3. Disability – a baseline Glasgow Coma Scale should be calculated to accurately assess the patient's LOC. A simple unambiguous command should be given "Hold up two fingers" A patient who squeezes the finger of a provider may simply be demonstrating a grasping reflex as opposed to purposefully following a command.

If depressed LOC is noted in the primary survey, the pupils should be examined quickly for symmetry and response to light. A difference greater than 1mm is considered abnormal.

Secondary Assessment

Once life threatening injuries have been identified and treated, a thorough secondary survey should be completed if time permits. Check for CSF in nose or ears. When placed on a gauze pad or cloth, CSF may diffuse out from the blood, producing a characteristic yellowish halo. Check for weakness or paralysis. These "lateralizing signs" tend to be indicative of TBI, whereas bilateral neurological deficits such as paraplegia, are more consistent with a spinal cord injury.

Serial Examinations

3% of patients with mild brain injury may experience an unexpected deterioration in their mentation. The primary assessment and the GCS should be repeated at frequent intervals. These patients can deteriorate rapidly so trends in the GCS or vital signs should be reported to the receiving facility.

Specific Head Trauma Considerations

Cerebral Concussion – can be thought of as a "shaking up" of the brain. The diagnosis is made when an injured patient shows an alteration in neurologic function, most commonly is a loss of consciousness, and no intracranial abnormality is identified when a CT scan of the brain is performed.

Skull Fractures

Skull fractures can result from either blunt or penetrating trauma. Linear fractures account for about 80% of skull fractures; however a powerful impact may produce a depressed skull fracture, where fragments of bone are driven toward or into the underlying brain tissue. A closed nondepressed skull fracture by itself is of little clinical significance but its presence dramatically increases the risk of an intracranial hematoma.

Basilar skull fractures should be suspected if CSF is draining from the nostrils or ear canals. Raccoon's Eyes or Battles Signs often occur with these fractures but may take several hours after the injury to develop.

Epidural Hematoma

Account for about 2% of TBI's and have a mortality rate of 20%. They often result from a low velocity blow to the temporal bone, like the impact of a baseball or a punch. The middle meningeral artery is damaged resulting in arterial bleeding that collects between the skull and dura mater. The classic history is that the patient experienced a brief loss of consciousness, and then regained consciousness (lucid interval) and then a rapid decline in consciousness. As LOC worsens a dilated and sluggish or nonreactive pupil on the side of the impact.

Subdural Hematoma

Results from venous bleeding from bridging veins that are torn during a violent blow to the head. Neurologic signs may be apparent immediately after the event or may be delayed days to months. Classified into three types;

1. Acute – neurological deficits can be identified within 72 hours of the injury and usually sooner. Mortality rate 60%
2. Sub Acute – develop more gradually over 3 to 21 days. Because of gradual accumulation, less damage is done with a mortality of about 25%
3. Chronic may present with neurologic symptoms months after a seeming minor head injury.. Commonly occurs during frequent falls particularly in the chronic alcoholic. Mortality rate is about 50%

Intracranial Hematoma

Damage to blood vessels within the brain itself may produce an intracerebral hematoma or cerebral contusion. These occur fairly commonly, accounting for 20-30% of severe brain injuries. One hematoma occurs at the point of impact as the brain collides with the inside of the skull. A second lesion may occur directly opposite from the point of impact as the brain tears away from the cranium.

Management

Airway

Patients with depressed LOCs may be unable to protect their airway. A retrospective study has documented an improved mortality rate in patients with TBI who were intubated in the field. Any patient with TBI and a GCS of 8 or less should be considered for intubation.

An intravenous dose of Lidocaine 1mg/kg may blunt an increase IVP during intubation.

Breathing

All patients with suspected TBI should receive supplemental oxygen. The use of pulse oximetry is strongly recommended because hypoxia can worsen neurological outcome. Sp02 should be maintained 95% or higher. ETC02 should be in the rate of 30-35. **Routine prophylactic hyperventilation has been shown to worsen neurologic outcome and should not be used.**

Circulation

Both anemia and hypotension are important causes of secondary brain injury, so efforts should be taken to prevent and treat these conditions. Because hypotension worsens brain ischemia, standard measures should be used to combat shock. In patient with TBI the combination of hypoxia and hypotension is associated with a mortality rate of about 75%.

To preserve cerebral perfusion attempts should be made to maintain a systolic blood pressure of at least 90-100mmHg.

Disability

Prolonged or multiple grand mal seizures can be treated with IV administration of a benzodiazepines.

Patients with suspected TBI should be placed in spinal immobilization. Some evidence suggests that a tightly fitting cervical collar can impede venous return of the head thereby increasing ICP. Application of a cervical collar is not mandatory as long as the head and neck are sufficiently immobilized.

CHAPTER EIGHT
SPINAL TRAUMA

Four concepts make the possible effect on the spine clearer when evaluating the potential for injury:

1. The head is like a bowling ball perched on top of the neck, and its mass often moves in a different direction from the torso, resulting in strong forces being applied to the neck.
2. Objects in motion stay in motion and objects at rest tend to stay at rest.
3. Sudden or violent movement of the upper legs displaces the pelvis, resulting in forceful movement of the lower spine. Because of the weight and inertia of the head and torso, force in an opposite direction is applied to the upper spine.
4. Lack of neurologic deficit does not rule out bone or ligament injury to the spine or conditions that have stressed the spinal cord to its limit of tolerance.

The following injuries have a potential for spinal cord injury:

- Any mechanism that produced a violent impact on the head, neck, torso, or pelvis
- Incidents that produce sudden acceleration, deceleration, or lateral bending forces to the neck or torso
- Any fall, especially in the elderly
- Ejection or a fall from any motorized or other powered transportation device
- Any victim of a shallow water incident

Any such patient should be manually stabilized in a neutral inline position before being moved even slightly until the need for spinal immobilization has been assessed.

Pathophysiology

Skeletal Injuries

Various types of injuries can occur to the spine, including the following

- Compression fractures of a vertebra that can produce total body flattening of the vertebra or wedge compression
- Fractures that produce small fragments of bone that may be in the spinal canal near the cord
- Subluxation which is a partial dislocation of a vertebra from its normal alignment in the spinal column
- Overstretching or tearing of the ligaments and muscles, producing an unstable relationship between the vertebrae

Patients who have a cervical spine injury also have a 10% chance of having another spine fracture. Therefore the entire spine must be immobilized. A lack of neurologic deficit does not rule out a bony fracture or an unstable spine.

Specific Mechanisms of Injury that Cause Spinal Trauma

Axial Loading – can occur in several ways. Most commonly, this compression of the spine occurs when the head strikes an object and the weight of the still moving body bears against the stopped head, such as when the head strikes the windshield.

Excessive Flexion, excessive extension and excessive rotation can cause bone damage and tearing of muscles and ligaments resulting in impingement on or a stretching of the spinal cord.

Sudden or excessive lateral bending requires much less movement than flexion or extension before injury occurs.

Distraction (overlongation of the spine) – occurs when one part of the spine is stable and the rest is in longitudinal motion. This pulling apart of the spine can easily cause stretching and tearing of the spine. Common mechanism in playground injuries and in hangings.

Spinal Cord Injuries

Primary injury occurs at the time of impact or force application. Secondary injury occurs after the initial insult and can include swelling, ischemia or movement of bony fragments.

Neurogenic Shock secondary to spinal cord injury represents a significant additional finding. Injury to the vasoregulatory fibers produces loss of sympathetic tone to the vessels or vasodilation. The skin will be warm and dry and the pulse rate will be slow. Instead of the tachycardia commonly associated with Hypovolemic shock, this type of injury is associated with a normal heart rate or slight bradycardia.

Assessment

Using Mechanism of Injury to Assess Spinal Cord Injury

Prehospital care providers have been taught that injury is based solely on mechanism of injury and that spinal immobilization is required for any patient with a motion injury. This generalization has cause a lack of clear clinical guidelines for assessment of spinal injuries. Assessment for spinal injuries should include assessment of the motor and sensory function, presence of pain or tenderness and patient reliability as predictors of spinal cord injury.

The primary focus of prehospital care should be to recognize the indications for immobilization rather than to attempt to clear the spine clinically.

As a guidelines, the provide should assume the presence of spinal injury and an unstable spine with the following situations:

- Any mechanism that produced a violent impact
- Incidents that produce sudden acceleration, deceleration or lateral bending forces
- Any fall, especially in the elderly
- Ejection or fall from a vehicle
- Shallow water diving accident.

The patient's ability to walk should not be a factor in determining whether a patient should be treated for a possible spinal injury.

An unstable spine can only be ruled out by the use of xray or the lack of any positive mechanism.

Penetrating Trauma

In general, if a patient did not sustain definite neurologic injury at the moment of trauma, there is little concern of a spinal injury.

GUIDELINES FOR IMMOBILIZATION

In the setting of blunt trauma, certain conditions should mandate immobilization:

1. Altered LOC
2. Spinal pain or tenderness. This includes pain or pain on movement, point tenderness, and deformity and guarding of the spinal area.
3. Neurologic deficit or complaint. These include paralysis, partial paralysis, weakness, numbness, prickling or tingling and neurogenic spinal shock below the level of the injury.
4. Anatomic deformity of the spine.
5. Intoxication – patients who are under the influence of drugs or alcohol are immobilized and managed as if they had a spinal injury
6. Distracting Injuries – severely painful or bloody injuries that may prevent the patient from giving reliable responses during assessment.
7. Communication Barriers.

In most situations the provider may feel that the mechanism of injury is not indicative of neck injury (i.e., falling on an outstretched had and producing a Colles fracture) In such situations, in the presence of a normal examination and proper assessment, spinal immobilization is not indicated.

Management

A suspected unstable spine should be immobilized in a supine position on a rigid longboard in a neutral inline position. Moderate anterior flexion or extension of the arms will not cause significant movement of the shoulder girdle.

Movement of a patient's head into a neutral inline position is contraindicated in a few cases. If careful movement of the head and neck into a neutral inline position results in any of the following, the movement must be STOPPED:

- Neck muscle spasm
- Increased pain
- Commencement or increase of a neurologic deficit such as numbness, tingling, or loss of motor ability
- Compromise of the airway or ventilation

Rigid Cervical Collars

Rigid cervical collars alone do not adequately immobilize; they simply aid in supporting the neck and promote a lack of movement. Must always be used with manual stabilization or mechanical immobilization provided by a suitable spinal immobilization device. A soft cervical collar is of no use as an adjunct to spinal immobilization. Even though it does not immobilize, a cervical collar aids in limiting head movement.

The collar must be the correct size for the patient. A collar that is too short will not be effective and will allow significant flexion. A collar that is too large will cause hyperextension or full motion if the chin is inside of it. If the head is not in the neutral inline position, use of any collar is difficult and should not be considered.

Most Common Mistakes

1. Inadequate immobilization – either the device can move significantly up or down on the torso or the head can still move excessively.
2. Immobilization with head hyperextended – the most common cause is a lack of appropriate padding behind the head.
3. Readjusting the torso straps after the head has been secured. This causes movement of the device on the torso, which results in movement of the head and cervical spine.

CHAPTER TEN
MUSCULOSKELETAL TRAUMA

When caring for the critical trauma patient, there are two primary considerations with regard to extremity injuries;

1. Do not overlook a life-threatening condition in the extremity or a life-threatening condition caused by an extremity injury.
2. The presence of horrible looking but noncritical extremity injuries must not distract from caring for life threatening injuries to other areas of the body.

Injuries to the extremities result in five major problems that require prehospital management:

1. Hemorrhage
2. Instability (fractures and dislocations)
3. Soft tissue injuries (strains and sprains)
4. Loss of tissue (amputation)
5. Compartment syndrome

Compression of the blood vessels will decrease the amount of blood loss. Increasing external pressure (applying direct pressure to the injury) serves two purposes:

1. It reduces the Transmural pressure, thus reducing blood loss.
2. It compresses the side of the torn vessel, reducing the area of the opening and reducing blood flow out of the vessel.

Fractures

If a bone is fractured, immobilizing it will reduce the potential for further injury and pain. Movement of the sharp ends of the bone inside the muscle and in the vicinity of vessels and nerve can produce significant additional injuries.

Closed Fractures

Fractures which the bone has been broken but the patient has no loss of skin integrity. Closed fractures may produce an additional source for major internal hemorrhage into tissue compartments.

Open Fractures

Those in which the integrity of the skin has been interrupted. They are usually cause by bone ends perforating the skin from the inside or the crushing or laceration of the skin by an object at the time of the injury.

Dislocations

Joints are held together by ligaments between the bones. The bones are attached to muscles by tendons. A dislocation is a separation of two bones at the joint. A dislocation produces an area of instability that's the prehospital care provider must secure. Dislocations can produce a great deal of pain and can be difficult to distinguish from a fracture.

Soft Tissue Injuries

Injuries to muscles and ligaments are more common that injuries to bones. Soft tissue injuries occur when a joint or muscle is torn or stretched beyond its normal limits.

- Strain – is a soft tissue injury that involves the tearing of muscle fibers that can occur anywhere in the musculature. Strains are characterized by pain with movement with little or no swelling
- Sprain – injury in which ligaments are stretched or partially torn. Characterized by extreme pain, swelling and possible hematoma. Externally they may look like a fracture.

Loss of Tissue

When tissue has been totally separated from an extremity, the tissue is completely without nutrition and oxygenation. This type of injury is an amputation or avulsion. Initially bleeding may be severe with these injuries; however the body's defense mechanism will cause the blood vessels at the injured site to constrict and the blood loss may diminish.

The longer the amputated portion is without oxygen, the less likely that it can be replaced successfully. Cooling the amputated body part – without freezing – will reduce the metabolic rate and prolong this critical time.

Assessment

Within the scope of triage, musculoskeletal trauma can be categorized into three main types;

1. Isolated non-life threatening musculoskeletal trauma (isolated limb fractures)
2. Non life threatening musculoskeletal trauma, but with multisystem life threatening trauma
3. Definite musculoskeletal life threatening injuries (pelvic and femur fractures with life threatening blood loss)

The purpose of the primary survey is to identify and treat life threatening injuries. The presence of a non life threatening musculoskeletal injury can be an indicatory of possible multisystem trauma.

- If enough force was delivered to fracture a humerus, a bone covered by thick muscle, can there also be damage to the lungs?
- Could a potential life threatening injury exist to the thoracic region or the organs of the upper abdomen with a simple rib fracture?
- Could a potential life threatening injury occur with multiple lacerations to the face and fractures to the underlying body structures of the face?

Mechanism of Injury

Determine MOI is one of the most important functions that a prehospital provider performs to adequately begin the management of a trauma patient. Based on the history of the MOI obtained, the provider should already have a high index o suspicion as to the injuries that the patient may have sustained.

Musculoskeletal injuries in and of themselves are not usually life threatening, but the injuries can alert the provider to a more serious injury.

Primary and Secondary Surveys

- Visually inspect the patient for swelling, lacerations, abrasions, hematomas, color, movement, capillary refilling time and deformity
- Feel for pulses, temperature, crepitation and movement.
- If the patient is conscious, question the patient about sensation, pain and MOI and ask the patient to describe how the pain feels.
- Note that voluntary movement of the extremities tests for neurologic and muscular involvement.

External hemorrhage should be identified during the primary survey and controlled after the patient's airway has been managed.

Pelvic Fractures

One of the major complications with a pelvic fracture is hemorrhage. Because of the amount of space within the pelvic cavity, a great deal of bleeding may occur with few external signs of difficulty. Therefore patients with pelvic fractures should be closely monitored for development of shock, and IV access should be obtained as soon as possible without delaying transport. Aggressive palpation or manipulation of the pelvis can increase blood loss. Gentle palpation is acceptable but should only be performed once.

Amputation

Psychological support should be given to the patient. If the patient does not know the extremity is missing, to tell him about the injury on scene may not be beneficial. The missing extremity should be located. The primary survey should be performed prior to looking for the part. Amputations may or may not be accompanied by significant bleeding. The patient may complain of pain distal to the amputation. This phantom pain is the sensation that pain exists in an extremity that has been removed.

Management

1. Manage any life threatening conditions
2. Manage any limb threatening conditions
3. Manage all other conditions (if time allows)

Adherence to these priorities does not imply that extremity injuries should be ignored or that injured extremities should not be protected from further harm. The provider must prioritize the critical injuries of patients with life threatening conditions in addition to extremity trauma.

If an extremity is under abnormal stress because of the patient's position or pathologic angulation, the provider should attempt to straighten the extremity. This will mean moving the extremity back to a normal anatomic position.

The general management for suspected fractures includes the following steps:

1. Stop any bleeding and treat the patient for shock
2. Evaluate for distal neurovascular function
3. Support the area of injury
4. Immobilize the injured extremity, including the joint above and the joint below the injury site
5. Reevaluate the injured extremity after immobilization for changes in distal neurovascular function.

Three points are important to remember when applying any type of splint:

1. Pad rigid splints to help adjust for anatomic shapes and to help increase the patient's comfort.
2. Remove jewelry and watches so they will not inhibit circulation as additional swelling occurs.
3. Assess neurovascular functions distal to the injury site before and after applying any splint and periodically thereafter

Splints: Equipment and Methods

- Rigid splints cannot be changed in shape. They require that the body part be positioned to fit the splint's shape. Examples of rigid splints include board splints and inflatable air splints. This group of splints also includes the longboard.
- Formable splints can be molded into various shapes and combinations to accommodate the shape of the injured extremity. Examples include; vacuum splints, pillows, blankets, cardboard splints, wire ladder splints
- Traction splints are designed to maintain mechanical inline traction to help realign fractures. Traction splints are most commonly used to stabilize femur fractures.

Dislocations

Suspected dislocations should be splinted in the position found. If a pulse is not detectable, the prehospital care provider may manipulate the joint to try to return blood flow.

Amputations

- Clean the amputated part by gentle rinsing with lactated ringers solution
- Wrap the part in sterile gauze moistened with lactated ringers solution, and place it in a plastic bag or container
- After labeling the bag or container, place it in an outer container filled with crushed ice
- Don't freeze the part by placing it directly on the ice or by adding another coolant such as dry ice
- Transport the part along wit the patient to the closest appropriate facility.

Femur Fractures

Femur fractures represent a special consideration because of the musculature of the thigh. The application of traction, both manually and by the use of a mechanical device will help promote tamponading of the internal third space bleeding and decrease the patient's pain. Contraindications to the use of the traction splint include the following:

- Hip injury with gross displacement
- Fractured pelvis
- Any significant injury to the knee
- Avulsion or amputation of the ankle or foot

Impaired or Absent Circulation

Impaired or absent circulation at or distal to the injury site will place an extremity in jeopardy. After stabilizing all life threatening conditions or injuries, the next priority is to correct any condition that threatens an extremity. Slight repositioning will often reinstate circulation and is not time consuming. The extremity should not be moved to the extreme range of either full extension or full flexion.

Pain Management

Analgesics are recommended for isolated joint and limb injuries but are generally not advocated in multisystem trauma patients.

Chapter Eleven
Thermal Trauma: Injuries Produced by Heat and Cold

Anatomy

The skin, the largest organ of the boy is composed of three tissue layers, the epidermis, dermis and subcutaneous tissue. The *epidermis* – the outermost layer is made up entirely of epithelial cells with no blood vessels. Underlying the epidermis is the thicker *dermis* made up of a framework of connective tissues that contain blood vessels, nerve endings, sebaceous glands, and sweat glands. The *subcutaneous layer* is a combination of elastic and fibrous tissue a well as fatty deposits.

The most important function of the skin is to form a protective barrier against the outside environment which helps protect against infection, prevent fluid loss and helps regulate body temperature. The dermal layer contains nerve endings that convey impulses between the brain and the body. When thermal injuries occur to skin tissue many or all of these functions are either destroyed or severely impaired. This protective layer must have adequate perfusion with red blood cells and other nutrients to survive.

Physiology

Normally the body functions within a narrow temperature rage of about 5 degrees on either side of 98 F. If the internal temperature falls outside this range, serious injury or death may occur.

Heat is transferred in one of four ways.

1. Radiation is the direct transfer of energy from a warm object to a cooler one by infrared radiation.
2. Conduction is the transfer of heat between two objects in direct contact with each other.
3. Convection is the heating of water or air in contact with a body, removal of that air (such as the wind) or water and then the heating of the new air or water that replaces what is left.
4. Evaporation of water from liquid to a vapor is an extremely effective method of heat loss.

A number of medications interfere with Thermoregulation:

1. Drugs that Increase Heat Production
    - Thyroid hormone
    - Amphetamines
    - Tricyclic antidepressants
    - Lysergic acid diethlamide (LSD)

2. Drugs that Decrease Thirst
    a. Haloperidol

3. Drugs that Decrease Sweating
    a. Antihistimines
    b. Anticholinergics
    c. Phenothiazines

4. Drugs that Change Thermoregulation by Vasoactive Ability
    a. Alcohol
    b. Nicotine

Heat Related Conditions and Injuries

Heat injury to the hands, feet, genitalia, or face and burns that completely encircle body areas are high priority injuries. Other key factors for the provider to consider in burn patients are inhalation injuries, length of exposure, core body temperature and patient's age, general health, other injuries and medical history.

Burn injury is the fourth leading cause of trauma deaths.

Associated injuries account for a significant part of morbidity and mortality caused by thermal injuries.

Cutaneous Heat Injuries (Burns)

Heat coagulates protein. That is how eggs cook. This is also the primary mechanism of injury with burns. The priorities of care for burn victims follow the same principles and priorities as for any trauma patient.

1. Stop the burn process (thermal or chemical)
2. Use the primary survey for assessment and management.
3. Provide specific care for individual wounds

Many patients die as a result of thermal injuries because they have inhaled the carbonaceous by products of combustion, inhaled toxic gases or been in a hypoxic environment for a sustained period of time – not from their actual burns.

A victim of a fire who has been in a confined area for any length of time must be considered to have carbon monoxide in his or her blood as well as potential pulmonary and systemic problems caused by toxic inhalation.

Burn Assessment

Scene Assessment

Assess the situation rapidly and thoroughly. Potential safety threats to the patient and the crew should be identified and addressed immeidatley.

Primary Survey

Close attention should be paid to the patient's airway, including a search for signs of inhalation injury. These include burns of the face and upper torso, singed facial and nasal hairs, carbonaceous sputum, hoarseness, stridor or burns around the mouth and nose. Smoke poisoning, carbon monoxide poisoning and respiratory injuries should be considered when the patient has been in a confined space.

Secondary Assessment

With critical patients in a potentially unstable environment, performing a secondary survey is inappropriate until both the patient and the environment has been secured from danger.

Burn Management

Airway and Breathing

Because of the high possibility of inadequate oxygenation and impaired circulation any patient conscious or unconscious who has sustained a thermal injury should be treated with high flow oxygen and the airway and breathing monitored for adequacy.

Burns that lead to laryngeal problems early include edema from steam or chemical injury. Although management using an Endotracheal tube may be required, edema of the laryngeal structures may allow only one attempt. The most experienced person on the scene should perform this attempt. The potential for laryngospasm is high in patients with a heat injured larynx.

Intubation should be accomplished early to allow positive pressure ventilation and prevent aspiration. If the hypoxic patients has a gag reflex, rapid sequence intubation should be considered.

Charred burns surrounding the entire chest, expansion of the thoracic cavity may be extremely limited. Restricted chest excursion, caused by lack of elasticity of the burned tissue, results in inadequate tidal and minute volumes.

Circulation

Associated injuries may lead to a decrease in blood volume, diminishing transport of oxygen. The decrease in blood volume commonly associated with burns does not happen immediately after the burn injury. Usually 6 to 8 hours pass before this type of shock occurs.

Fluid replacement should be based on fluid in the first 24 hours = 4ml x % of BSA x WGT in KG

Pain Management

The pain experienced by a burn patient is related to the severity of the burn. Third degree burns are painless because of the destruction of the nerve receptor endings, however second degree burns involve a great deal of pain.

Analgesics such as Morphine or nitrous oxide can be used. Because morphine can cause vasodilation, especially if Hypovolemia is present, fluid resuscitation must be adequate. Morphine is reported to be metabolized faster in the presence of burns and must be dosed accordingly.

Fentanyl is become more popular because it does not have the hemodynamic and ventilatory effects of morphine. The use of all analgesics should be based on the patient's overall condition, not just the amount of pain, however, pain should be treated adequately. Any analgesics should be given IV.

Cool moist dressing can be used if the burn is less than10%. The preferred method of dressing burns is with a dry sterile dressing.

Wound Care

Patients with serious burns should receive car at centers that have special expertise and resources. Initial transport or early transfer to a burn unit should result in a lower mortality rate and fewer complications. Injures requiring Burn Unit care:

1. Inhalation injury
2. Partial thickness burns over greater than 10% of the total body surface area
3. Full thickness burns in any age group
4. burns that involve the face, hands, feet, genitalia, perineium or major joints.
5. Electrical Burns including lightning injury
6. Chemical Burns
7. Burn injury patients with preexisting medical disorders that could complicate management, prolong recovery or affect mortality
8. Any patients with burns and concomitant trauma in which the burn injury poses the greatest risk of morbidity or mortality.
9. Burned children in hospitals without qualified personnel or equipment for the care of children
10. Burn injury in patients who will require special social, emotional or long-term rehabilitative intervention

A patient's age has a significant effect on his or her survival. The very young and the very old respond poorly to burn injury. Reduced vital organ function, decreased resistance to infection and atherosclerotic vascular disease make age a major factor in burn management. As patient's age increases there is a gradial increase in mortality from burns. This gradual decrease in survival can be estimated by adding the age of the patient in years to the percentage of BSA of partial and full thickness burns. For example the probability of mortality of a

60 year old patient with partial full thickness burns on 30% of his body can be estimated as 60 (age in years) x 30% (BSA burned = 90% probability of death.

Associated Non Burn Injuries

The patient who is displaying signs of shock soon after the injury is most probably not in shock from the burn but from associated injuries that produce Hypovolemia, such as internal hemorrhage from damaged organs or broken bones or from severe hypoxia cause by pulmonary injury.

Chemical Burns

The skin comes in contact with various caustic agents. The skin will contribute water to any reaction so it is better to flush and dilute the chemical with copious amounts of water. Flushing should begin immediately at the scene and continue until arrival at the receiving facility. Some chemicals require special treatment to neutralize.

- Dry lime and soda ash – Like any powder, these powders should be brushed off because contact with water will form a corrosive substances. The contaminated areas should not be irrigated unless they are already wet. Large quantities of water should be used if the burning process has already begun.
- Phenol – widely used industrial cleaning agent. Although phenol is not water soluble, flushing with large amounts of water may be beneficial.
- Lithium and sodium metal – there are substances that react with water, releasing heat and toxic fumes. Any large metal chucks that remain in or around the burn should be removed and placed in oil.
- Hydrogen fluoride and hydrofluoric acid 0 death from these types of burns have been reported with as little as 2.5% of BSA involved. When transport is prolonged, calcium gluconate or calcium chloride can be mixed with lubricant jelly and applied to the burned area which may slow the damage.

Electrical Burns

The degree of tissue damage in an electrical burn is related to the amount of current involved and the duration of the exposure.

Electrical burns are actually thermal burns as the resistance of the tissues converts electrical energy into heat in direct proportion to the amperage and current of the source.

The three types of electrical injury are as follows:

1. Current Burns – Electrical current passes through the tissue, causing extensive areas of necrosis along the current's pathway. The skin is often charred and in some cases has exploded apart.
2. Arc (Flash) Burns – Arc burns occur by arcing of electricity between two contact point close together near the skin. With these injuries the skin

can be exposed to temperatures of 4500 to 5400F producing significant cutanous burns. Such injures are typically superficial and are recognized by the loss or singeing of hair along the arc's pathway. Deep injury may be evident, especially at flexed joints, as the electricity jumps from body part to body part, such as the forearm to the upper arm or from the arm into the chest.

3. Contact Burns – Contact burns occur when electrical current passes through a metallic object such as a wire or tool and causes the metal to become superheated. The object may slice through tissue and usually results in very deep burns.

The following are key points to consider with electrical injuries;

- Do not become part of the circuit. However, patients do not store electricity and are safe to touch if they are no longer in contact with the electrical source
- Anticipate greater tissue damage than is visible externally.
- Examine the patient for associated injuries to bones and internal organs, and immobilize as necessary
- Administer volume replacement to protect the kidneys from tubular necrosis and subsequent shutdown.
- Monitor the patient for possible cardiac dysrhythmias
- Transport all electrical burn patients to an appropriate facility.

Carbon Monoxide Poisoning

All patients who have sustained a thermal injury in an enclosed area, whether the patient presents with symptoms or not should be suspected of having and treated for carbon monoxide poisoning. The symptoms include hypoxia with altered mental status, neurologic deficits, and severe headache. The presence of cherry red color, although classic is seldom seen because it is masked by cyanosis from unoxygeanted hemoglobin. Carbon monoxide, a colorless, odorless, tasteless gas has greater than 200 times the affinity for hemoglobin than for oxygen. Pulse oximetry will give a falsely high reading in these patients. Patients with very high concentrations of carbon monoxide may require hyperbaric oxygen treatment.

Systemic Heat Injuries

Elevated body temperatures, derived externally from the environment or internally from increased metabolism can cause illness and death by overwhelming the body's ability to dissipate heat.

Heat Exhaustion results from excessive fluid and electrolyte loss through sweating and lack of adequate fluid replacement when the patient is exposed to high environmental temperatures for a sustained period of time, usually several days.

Assessment

May complaint of headache, drowsiness, euphoria, nausea, lightheadedness or anxiety or display signs of fatigue and apathy. They may feel better while lying down but become lightheaded when they attempt to stand or sit. Their skin usually feels cool and clammy. Profuse sweating is not unusual. Ventilations and pulse rates may be rapid and the pulse may feel thready at the radial artery. Systolic blood pressure may be normal or slightly decreased and an orthostatic test of vital signs will be positive. The patient's core temperature may be normal or slightly elevated.

Treatment

Similar to that of the Hypovolemic patient, although the patient should be moved into a cool environment rather than a warm one. Keep the patient supine and remove any heavy clothing. Even if the patient is alert, oral hydration is not usually effective. Lactated ringers or NSS should be administered. Two to four liters of crystalloid infusion for an adult is not unusual.

Heat Cramps – usually occur in individuals with heat exhaustion who are not acclimated to a hot environment. Heat cramps accompany heat exhaustion in up to 60% of cases. Heat cramps occur in a patient at rest and are often confused with exercise cramps that result from a buildup of lactic acid. Heat cramps are due to loss of balance between electrolytes and water.

Management

Immediate management is to remove the patient from the hot environment and gentle stretching of the muscle to alleviate the cramp. That patient should drink fluids containing an electrolyte solution. Salt tablet usage is discouraged because the osmotic fluid shift can cause omitting and damage to the stomach lining.

Heat Stroke – can occur suddenly from such circumstances as a baby left in a hot vehicle, an adult transported in improperly ventilated vehicles or exposure to confined spaces with poor ventilation. There are two different kinds of heat stroke;

1. Classical heat stroke is most often seen in the elderly. This usually age related problem can be worsened by the various medications the patient may be taking. Exposure to high room temperature without air conditioning over time can lead to dehydration and is a classic presentation during the hot summer months.
2. Exertional heat stroke stems from a combination of high environment temperature, high humidity and physical activity. All of the conditions can rapidly elevate internal heat production and limit the body's ability to unload heat.

Assessment

Present with hot flushed skin. They may or may not be sweating depending on where they are found and whether they have classical or Exertional head stroke. Blood pressure can be elevated or diminished and the pulse is usually tachycardic and thready. The patient's LOC can range from altered and confused to unconscious. Seizures may also occur. Any patient who is warm to the touch with an altered mental status should be suspected of having heat stroke and treated accordingly.

Management

Heat stroke is a true emergency. Management consists of rapidly cooling the patient with whatever means available. Cooling should begin before transport with special attention given to the cooling of the head and scalp. Blood vessels are closest to the surface in the groin, axilla, and anterior lateral neck. About 40% of heat loss occurs in the head and neck.

Cold-Related Conditions and Injuries

Cutanous Conditions of Cold

Unless the injury is due to a super cooled liquid splash, cold injuries to the skin are generally isolated to such body areas as the fingers, toes, hands, feet, face and ears—places where a significant difference exists between the surface area and the blood volume that circulates through the body part.

Frostbite is the actual freezing of the water in the body tissue as a result of exposure to freezing or below freezing temperatures. The longer the period of exposure, the more blood flow is reduced to the periphery. Frostbite is divided into two types:

1. Superficial frostbite, also called frostnip is the less severe type of frostbite. The patient feels slight pain or a burning sensation in the affected extremity which later develops into numbness. The skin of the affected area will appear grayish or yellow. When digital pressure is applied to the area, the tissue below the discolored extremity will feel soft and malleable like normal tissue.
2. Deep frostbite develop if a patient does not recognize or react to the numbing sensation of the extremity. If the freezing of the tissue continues, the affected area becomes more waxy-looking. When the nerve endings become frozen, the numbness and pain stop. The frozen parts are hard and not pliable when the affected tissue is compresed.

Assessment

Superficial frostbite is usually assessed through a combination of recognizing the environmental conditions; considering the patient's chief complaint of fpain or numbness of a digit.

Management

The immediate management is to move the frostbite patient from the cold environment into a heated area. Hypothermia should always be suspected. The affected area should be warmed against a warm body surface. The prehospital care for deep frostbite is appropriate shelter, supportive care and early transport. Attempts to begin rewarming of deep frostbite patients in the field can be hazardous to the patient's eventual recovery and are not recommended unless long transport times are involved.

- Rewarming needs to occur rapidly
- The rewarming process is extremely painful. IV analgesics are usually necessary.
- If rewarming attempts have been started and for some reason the extremity is allowed to refreeze, gangrene may occur.

Systemic Conditions of Cold

Hypothermia is defined as the condition in which the core body temperature is measured below 95F when using a rectal thermometer placed at least 6 inches into the rectum. Unlike frostbite, hypothermia can occur at temperatures well above freezing.

Hypothermia can be fatal within 2 hours. A 50% mortality rate exists in cases of secondary hypothermia caused by complications of other injuries and in severe cases in which the core body temperature is below 90F.

Severity and Exposure

The duration of exposure that contributes to the hypothermic condition is divided into three categories.

1. *Acute* Sudden lowering of core temperature in minutes such as immersion in cold water.
2. *Subacute* Lowering of the core temperature over 1 hour to several days.
3. *Chronic* Lowering of the core temperature slowly over weeks (usually occurs in the elderly)

Hypothermic Situations

Immersion Hypothermia – occurs when an individual is placed into a cold environment without preparation or planning. Someone who has fallen through the ice in a pond or river and is in immediate danger of hypothermia.

Submersion Hypothermia is a combination of hypothermia and hypoxia. Successful resuscitation without neurologic impairment has occurred in cases of cold water submersion of up to 66 minutes. Several factors influence the outcome of a cold water submersion patient.

- Age – the younger the patient the better survival.
- Submersion time. The shorter the length of submersion, the less chance the patient has for cellular damage caused by hypoxia
- Water Temperature The colder the water the better chance of survival. This is probably due to a decreased metabolism when the body is quickly chilled.
- Struggle – victims who struggle less have a better chance of being resuscitation. Less struggle means less muscle activity which translates to less head production and less vasodilation.
- Cleanliness of the water. Patients generally do better after resuscitation if they were immerged in clean water rather than muddy or contaminated water.
- Quality of CPR and resuscitative efforts. Patients who receive adequate and effective CPR combined with proper rewarming and ALS measures do better than patients for whom these measures were substandard.
- Associated injuries or illness. Patients with an existing injury or illness or who become ill or injured in combination with the submersion do not fair as well as otherwise healthy patients.

Field Hypothermia

Involves protracted exposure to the elements, usually by health individuals who participate in outdoor sports and adventure activities.

Urban Hypothermia is sometimes missed because of the possibility of a more common illness or injury. The underlying hypothermia may hamper the effectiveness of normal treatment modalities. Hypothermia should be suspected in all of the following cases.

- Newborns and infants
- Patients with alcohol-related illness or injury
- Patients with drug use or overdose, including both recreational drug abuse and abuse of certain prescription drugs.
- Patients with cocaine-induced hypothermia
- All elderly patients, regardless of obvious injury or illness
- Burn patients
- Patients with malnutrition
- Homeless individuals who are under clothed and/or in shelters.

Assessment

The best assessment finding that a provider can seek when suspecting hypothermia is muscular shivering and the patient's LOC. Mildly hypothermic patients will have altered LOC and usually show signs of confusion, slurred speech, altered gait and clumsiness.

When a patients core temperature falls below 90F profound hypothermia is present and the patient will probably not complaint of feeling cold. Shivering will be absent, and the patient's LOC will be markedly decreased, possibly to the point of unconsciousness. The patient's pupils will react slowly or may be dilated and fixed.

Management

Prevention of further heat loss, gentle handing, initiation of rapid transport and in certain situations; rewarming.

Wet clothing should be removed by cutting to avoid unnecessary movement and agitation of the patient. The patient's head should be covered with warm blankets. If the patient is conscious and alter, he can drink warm sweet fluids. The patient should avoid alcohol and caffeine drinks. IV fluids should be warmed to 104F and administered if an IV line can be started without unduly agitating the patient. The patient should ot be given cold(room temperature) fluids. Hot packs or massaging of the patient's extremities are not recommended.

If the ECG shows any dink of organized electrical rhythm CPR should not be started regardless of the absence of a palpable pulse. CPR will precipitate ventricular fibrillation in such patients. If VF is present, normal CPR should be initiated. In the profoundly hypothermic patient, defibrillation and conventional ACLS drug therapy may not be beneficial because o the depressed core temperature.

Chapter Twelve
Special Considerations in Trauma of the Child

Injury is the most common cause of death of American children. Tragically 20-40% of these deaths may be preventable.

Kinematics of Pediatric Trauma

A child's size produces a smaller target to which linear forces are applied. Because of diminished body fast, increased elasticity of connective tissue, and close proximity of multiple organs these forces are not dissipated as well as in the adult. The skeleton of a child is less able than that of an adult to absorb the kinetic forces applied during a traumatic event and may allow significant internal derangements with apparently minor external injury.

Thermal Homeostasis

The ratio between a child's body surface area and body volume is highest at birth and diminishes through infancy and childhood. This means that relatively more surface area exists though which head can be lost quickly. Thermal energy loss becomes a significant stress factor in a smaller child. Severe hypothermia will frequently initiate irreversible cardiovascular collapse.

Psychological Issues

A child's ability to interact with unfamiliar individuals in strange surroundings is usually limited and makes history taking and cooperative manipulation extremely difficult.

Recovery and Rehabilitation

The effect that injury may have on subsequent growth and development is immense. Unlike the mature adult, the child must not only recover from the injury but must also continue the normal growing process and development.

Major organ injury may exists in the face of minor external signs. A high index of suspicious an clinical common sense should prompt transport of the child to an appropriate facility for a more thorough evaluation when any possibility of severe injury exists.

Pathophysiology

The ultimate result of care for the injured child is largely determined by the quality of care rendered in the first moments after injury. The most common cause of immediate death in the child are hypoxia, massive hemorrhage and overwhelming central nervous system trauma.

Hypoxia

The first priority is the establishment of a patent airway. Confirming that a child has an open and functioning airway does not preclude the need for assisted ventilation and supplemental oxygen, especially where CNS injury or hypoperfusion may be present. Injured children can rapidly deteriorate from labored breathing and tachypnea to a state of total exhaustion and apnea.

Adequate oxygenation is especially critical to the initial care of the patient with traumatic brain injury. If possible, patients who require intubation should be preoxygenated. In many cases, this basic maneuver may be all that is necessary to begin reversal of hypoxia and improve the margin of safety when intubation is performed.

Hemorrhage

Most pediatric injuries do not cause immediate exsanguination. Most injured children who require emergency car have multiple organ injuries with at lease one associated with blood loss.

The injured child compensates for hemorrhage in increasing SVR at the expense of peripheral perfusion. Blood pressure alone is an inadequate marker for shock. Ineffective organ perfusion is a more appropriate indication of shock and is evidenced by a decreased LOC, diminished skin perfusion, poor color, and delayed capillary refilling time and decreased urine output. The early signs of hemorrhage in the child may be subtle and difficult to identify. Tachycardia may be caused by Hypovolemia or may be the result of fear or pain.

Inadequate resuscitation could result in profound cardiovascular collapse at a later time. A major reason for the rapid transition to Decompensated shock is the gradual loss of RBC mass. Restoration of shed blood with crystalloid solutions will provide a transient increase in blood pressure, but the solutions will dissipate as the fluid leaks across the membranes. The net effect is that circulating volume will be gradually replaced with an increasingly diluted RBC mass, which has virtually no oxygen carrying capacity. Any child who requires more than on 20cc/kg bolus of crystalloid solution may be rapidly deteriorating.

A common error in the initial evaluation of an injured child is the tendency to over resuscitate the patient once venous access has been secured. In the face of minimal bleeding and normal vital signs a bolus of 20ml/kg can artificially dilute the hematocrit and introduce a potential error in the diagnosis of hemorrhage. Given the high incidence of traumatic brain injury with associated blunt trauma and the relatively low incidence of sever hemorrhagic shock, fluid over resuscitation of the child with a traumatic brain ijury may be more detrimental than effective and may actually worsen evolving cerebral edema. Careful assessment of the child's vital signs and evaluation of the effect of therapeutic intervention must be the primary consideration immediately after the injury.

Brain Injury

The pathophysiologic changes that follow trauma to the CNS begin with a matter of minutes. Many children present with CNS 9nuries that are made more severe by subsequent hypoperfusion or ischemia. Adequate oxygenation and ventilation are extremely critical in the management of TBI. Even densely comatose children may recover if they do not develop cerebral hypoxia.

Children with traumatic brain injury frequently present with a mild degree of obtundation and they may have sustained a period of unconsciousness not recorded during initial evaluation. A history of loss of consciousness is one of the most important prognostic indicators of potential CNS injury.

CNS injury is a pathophysiologic continuum that begins as an initial depolarization of the intracranial neurons and proceeds along a recognizable course of secondary edema and hypoperfusion. The absence of adequate baseline assessment makes ongoing follow up and evaluation of intervention extremely difficult. A transient neurologic deficit may be the only indicator of a potentially significant cervical spinal injury.

Assessment

The immediate availability of appropriately sized equipment is essential for successful initial management of an injured child

Airway

The relatively large tongue and more anterior position of the airway make small children more likely to have an airway obstruction than adults.

The most reliable means of ventilation in the child with airway compromise is direct orotracheal intubation. In the absence of appropriate intubation equipment, BVM ventilation with 100% oxygen is an acceptable alternative.

Breathing

A significantly traumatized child typically needs an oxygen concentration of 85-100%. When hypoxia occurs in the small child, the body compensates by increasing the ventilatory rate and by a strenuous increase in effort, including increased thoracic excursion efforts and the use of accessory muscles in the neck and abdomen. This increased effort can produce severe fatigue, resulting in ventilatory failure. Ventilatory distress can rapidly progress to ventilatory failure, then respiratory arrest and ultimately cardiac arrest secondary to the respiratory problem.

Ventilatory effort becomes more labored and may include the following;

- Head bobbing with each breath
- Gasping or grunting
- Flared nostrils

- Stridor or snoring
- Suprasternal, supraclavicular and intercostal retractions
- Use of accessory muscles of neck and abdomen
- Distention of the abdomen when the chest falls

The effectiveness of a child's ventilation should be evaluated using the following indicators;

- Rate and depth and effort
- Breath sounds confirm the depth of exchange
- Wheezing, rales or rhonchi indicate inefficient alveolar oxygenation
- Pink skin indicates adequate ventilation
- Dusky, gray, cyanotic or mottled skin indicates insufficient oxygen exchange
- Anxiety, restlessness, or combativeness are possible early signs of hypoxia
- Lethargy, lowered LOC, or unconsciousness are probably advanced signs of hypoxia.

Circulation

The survival rate from immediate exsanguinating injury is low in the pediatric population. Fortunately the incidence of this type of injury is also low. External hemorrhage should be identified and controlled during the primary survey.

If the primary survey suggests severe hypotension the most likely cause is blood loss – either through a major external wound, an intrathoracic wound, or loss of blood from a major intraabdominal injury.

Because of compensation children with hemorrhagic injury frequently present with only slightly abnormal vital signs. All injured children should have their blood pressure, heart rate, ventilatory rate and overall CNS status monitored closely.

In the child signs of significant hypotension develop with the loss of approximately 25% of the circulatory volume.

The concept of evolving shock must be of prime concern in the initial management of an injured child and is a major indication for transport to an appropriate facility and proper physician evaluation of even minor appearing injuries.

Management

The keys to pediatric trauma survival are rapid assessment, appropriate aggressive management and transport to a facility capable of managing pediatric trauma.

Airway

The primary goal is restoration of adequate tissue oxygenation as quickly as possible. A patient airway should be ensured and maintained with suctioning, manual maneuvers and airway adjuncts along with proper spinal protection throughout.

Visualized orotracheal intubation is the preferred method of definitive airway control.

In providing initial cervical spine stabilization of the child, the size disproportion of the head should be considered. Adequate padding should be placed under the patient's torso so that the cervical spine is maintained in a straight line rather than forced into slight flexion because of the head.

The Sp02 should be kept at greater than 95%.

Circulation

Once the patients external hemorrhage is controlled, perfusion should be evaluated. The pediatric vascular system is commonly able to maintain a normal blood pressure until severe collapse occurs at which point it is often unresponsive to resuscitation.

Fluid resuscitation should be started whenever signs of compensated Hypovolemic shock are present. Lactated Ringers solution or NSS in 20cc/kg boluses should be used. Transportation should not be delayed to start IV therapy.

Vascular Access

Fluid replacement in a child with severe hypotension or signs of shock must deliver adequate fluid volume to the right atrium as directly as possible to avoid further reducing cardiac preload. The most appropriate initial site for IV access is above the diaphragm. It should first be attempted at the antecubital. In the absence of adequate venous access at this location, the Saphenous vein at the ankle should be considered. If access is unsuccessful, central access via intraosseous infusion should be considered.

Disability

Traumatic Brain Injury (TBI) continues to be the most common cause of death in the pediatric population.

Initial assessment of the LOC is a rapid and reliable prognostic exercise. Regardless of the outcome of the neurologic evaluation on the first exam, any child who sustains potential brain injury may be susceptible to cerebral edema and hypoperfusion. This can even result from trauma that appear minor. Any child who presents with even an transitory loss of consciousness should be assume to have sustained a significant level of mechanical trauma to the brain stem.

A baseline GCS score should be assessed and repeated during transport. Supplemental oxygen should be administered and if possible, pulse oximetry should be monitored.

Because the intracranial mass may not present symptomatic until rapid decompensation occurs, an infant with a bulging fontanelle should be considered to have a more severe brain injury.

Children with a GCS of 8 or less may benefit from intubation. However prolonged attempts at securing an Endotracheal airway should not delay transport. A child with signs and symptoms of increased ICP such as a sluggishly reactive or nonreactive pupil, hypertension, bradycardia and motor deficits, hyperventilation may transiently lower ICP. This is easily achieved in the sensory-depressed or comatose child by initial airway control, ventilation and supplemental oxygen. End tidal C02 monitoring can guide management with the target range being 25-30mmHg.

Seizures may occur soon after the brain injury; however recurrent seizure activity is worrisome and may require treatment with IV boluses of diazepam (0.1 to 0.2mg/kg/dose)

Spinal Trauma

The indication for spinal immobilization in a pediatric patient is based on the mechanism of injury and physical findings; the presence of other injuries that suggest violent or sudden movement of the head, neck or torso or the presence of specific signs of spinal trauma. The threshold for performing spinal immobilization is often lower is children because of their inability to communicate or otherwise participate in their own assessment.

The prehospital provider should also be familiar with the techniques of immobilizing a young child in a car seat.

Thoracic Injuries

The extremely resilient rib cage of a child with it incomplete calcification reduces the energy transferred through the thoracic cage to the intrathoracic organs. As a result, a child may have significant organ injury, disruption of the vascular anatomy, or simple contusions without even the slightest degree of skeletal abnormality or external examination.

Being aware of this potential problem requires continuous careful monitoring of a child's fluid status to ensure prevention of gross IV fluid overload. Unlike adults, rib fractures in children are associated with a high risk of death. Even if they are an isolated injury, the presence of one or more fractured ribs in an indication of multisystem trauma, even in the absence of other apparent signs.

The possibility of a cardiac contusion should also be considered in children who sustain blunt thoracic trauma. The key items in managing thoracic trauma involved careful attention to ventilation and timely transport to an appropriate facility.

Abdominal Injuries

Because of the large size of the torso relative to the extremities in children, abdominal injuries are a common problem. The presence of blunt trauma to the abdomen; an unstable pelvis; post traumatic abdominal distention, rigidity, or tenderness or otherwise unexplained levels of shock can be associated with possible hemorrhagic shock.

Extremity Shock

In comparison with the adult skeleton a child's skeleton is actively growing and consists of large proportion of cartilaginous tissue and metabolically active growth plates. Children with skeletal trauma frequently sustain major deforming forces before developing fractures or disruptions of their bony skeleton.

Fractures that involve the growth plate should be carefully identified and managed in a manner that will not only ensure adequate healing but also prevent subsequent displacement or deformity as the child grows.

Associated vascular injuries with orthopedic injuries in children should always be considered and the distal pulse should be evaluated carefully.

Transport

Because timely arrival at an appropriate facility may be the key element in the patient's survival, triage is an important consideration of management.

As many as 40% of pediatric traumatic deaths could be classified as preventable. These statistics have been one of the primary motivations for the development of regionalized pediatric trauma centers where continuous high-quality sophisticated care can be provided.

The Battered and Abuse Child

Child abuse is a significant cause of childhood injury. In many jurisdictions, prehospital care providers are legally mandated reporters if they identify potential child abuse. Data suggests that up to 50% of abused children who are released back to their abusers subsequently die of further abuse episodes.

Suspect abuse if any of the following is noted;

- A discrepancy exists between the history and the degree of physical injury

- A prolonged interval has passed between the time of the injury and when medical care is actually sought.
- A history of the injury is inconsistent with the developmental level of the child. For example, a history indicating that newborn rolled off a bed would be suspect because newborns are developmentally unable to roll

Certain injury types also suggest abuse;

- Multiple bruises in varying stages of resolution
- Bizarre injuries such as bits, cigarette burns or rope marks
- Sharply demarcated burns or scald injuries in unusual areas.

Chapter Thirteen
Special Considerations in Trauma of the Elderly

Elderly is divided into three specific categories:

- Middle age: 50-64
- Late age: 65-79
- Older age: 80 years and older

The sudden illness and trauma in the elderly present a different prehospital care dimension than in younger patients. The range of disabilities experienced by the elderly is enormous and field assessment may take longer than with younger patients.

Anatomy and Physiology of Aging

The aging process causes changes in physical structure, body composition and organ function, and it can create unique problems during care. Organ systems have achieved maturation, and a turning point in physiologic growth has been reached. The body gradually loses its ability to maintain homeostasis, and viability declines over a period of years until death occurs. The fundamental process of aging occurs at the cellular level and is reflected in both anatomic structure and physiologic function.

Influence of Chronic Medical Problems

Statistically an older person is more likely to have one or more significant medical conditions.

Elderly trauma patients die for the same reasons as trauma patients of any age. However, often because of preexisting physical conditions, the elderly can also die from less severe injuries and die sooner than younger patients.

Respiratory System

Ventilatory function declines in the elderly partly as a result of the inability of the chest cage to expand and contract and partly from stiffening of the airway. The elderly patient requires more exertion to carry out daily activities. Impaired cough and gag reflexes along with poor cough strength and diminished esophageal sphincter tone results in an increased risk of aspiration.

The brittle nature of capped teeth, fixed bridges or loose, removable bridges and dentures poses a special problem of possible foreign bodies that can obstruct the airway.

Cardiovascular System

Disease of the cardiovascular system are the major cause of death in the elderly. Age related decreases in arterial elasticity lead to increased peripheral vascular resistance. The myocardium and blood vessels rely on their elastic, contractile and distensible properties to function properly. The cardiac output diminishes by approximately 50% from 20 to 80 years of age. As many as 10% over the age of 75 will have some degree of overt congestive heart failure.

In the elderly trauma patient, this reduced circulation contributes to cellular hypoxia. The result is cardiac dysrhythmias, acute heart failure and even sudden death. The ability for the body to compensate for blood loss or other causes of shock is significantly lowered in the elderly due to a diminished inotropic response to catecholamines.

Care must be taken while treating hypotension and shock not to cause volume overloading with aggressive fluid resuscitation.

Nervous System

Even though many elderly patients may have baseline neuro deficits, when assessing an elderly trauma patient, any impairment in mentation should be assumed to be the result of an acute traumatic insult such as shock, hypoxia or brain injury.

Vision and Hearing

Approximately 28% of elderly persons have hearing impairment and approximately 13% have visual impairment.

Pain Perception

The elderly may not perceive pain normally, placing them at increased risk of injury from excesses in heat and cold exposures. Living with daily pain can cause increased tolerance to pain. The prehospital provider should locate areas where the pain has increased or where the pain area has enlarged.

Musculoskeletal System

Bone loses mineral as it ages. Bone loss may be more rapid in women and accelerated after menopause. Muscle fatigue in the elderly can cause many problems that affect movement, falls being one of the most frequent.

Skin

As the skin ages, sweat and sebaceous glands are lost. Loss of sweat glands reduces the body's ability to regulate temperature.

Assessment

Mechanism of Injury

Falls

Are the leading cause of trauma death an disability in those over 75 years of age. Most falls occur as a result of the inherent nature of aging with the changes in posture and gait. Long bone fractures account for the majority of injuries with fractures of the hip resulting in the greatest mortality and morbidity rates. The mortality rate of a hp fracture is 20%.

Vehicular Trauma

Leading cause of trauma death in the geriatric patient between 65 and 74. Alcohol is rarely involved as compared with MVC in younger patients.

Assaults

The elderly are highly vulnerable to crime. Violent assaults have been estimated to account for more than 10% of trauma admissions in the elderly.

Secondary Assessment

- The body may not respond the same as in younger patients.
- Additional patience may be needed because of the patient's hearing or visual deficits
- Assessment of the elderly requires different questioning tactics
- A significant other may been to be involved
- Attention should be paid to sensory deficits
- Altered comprehension of neurologic disorders are a significant problem for many elderly patients
- Firmness, reassurance and clear simple questioning may be helpful
- Pay attention to impaired hearing, sight, comprehensive and mobility capabilities
- Shake the patient's hand to feel for grip strength, skin turgor and body temperature.
- Look for behavioral problems or manifestations that do not fit the scene.
- Look at the patient's state of nourishment
- Elderly patients have a decrease in skeletal muscle weight, widening and weakening of bones, degeneration of joints and osteoporosis.
- An elderly patient's vital capacity is diminished by 50%.