Trauma

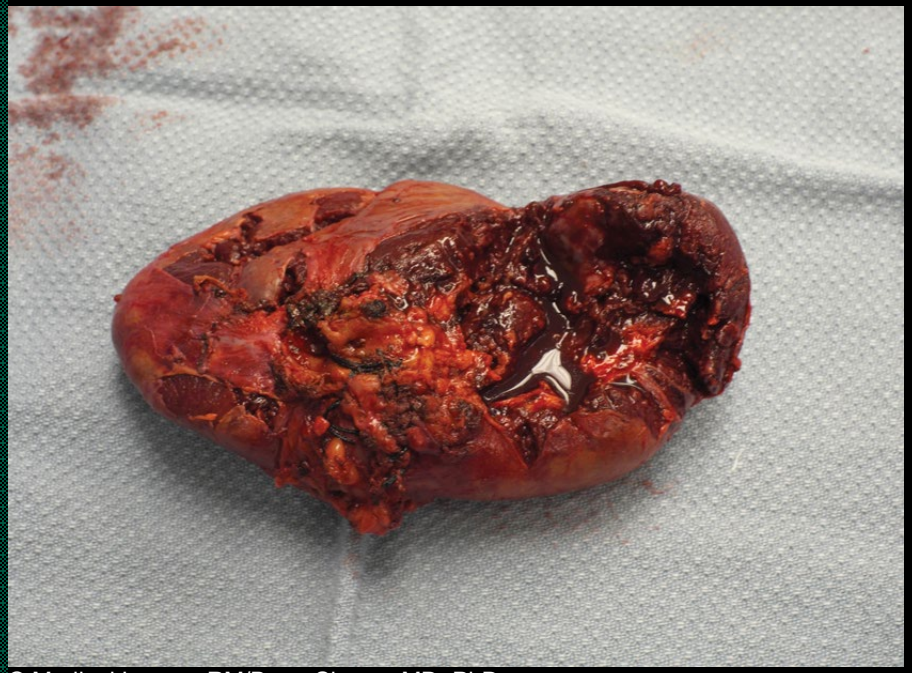
Pea Ridge Fire Department EMS refresher

Introduction

- Trauma is the primary cause of death and disability between ages 1 to 44 years.
- Mechanics and biomechanics of trauma will help you analyze and manage your patient's injuries.

Trauma

- Injury that occurs when an external source of energy affects the body beyond its ability to sustain and dissipate the energy



Trauma

- Different forms of energy produce different kinds of trauma.
  - Mechanical energy
  - Chemical energy
  - Thermal energy
  - Electrical energy
  - Barometric energy

Trauma

- Biomechanics
  - Study of physiology and mechanics of living organisms
- Kinetics
  - Study of the relationship among speed, mass, direction of force, and physical injury caused by these factors

Factors Affecting Types of Injury

- Ability of body to disperse energy delivered
- Force and energy
- Duration and direction
- Position of victim

Factors Affecting Types of Injury

- The impact resistance of body parts has a bearing on types of tissue disruption.
  - Organs that have gas inside are easily compressed.
  - Liquid-containing organs are less compressible.

Factors Affecting Types of Injury

- Understanding the effects of forces will help to assess the mechanism of injury (MOI).

Kinetics

- Velocity (V): Distance per unit of time
- Acceleration (a): Rate of change of velocity
- Gravity (g): Downward acceleration imparted to any object moving toward earth
- Kinetic energy = mass/2 $\times$ velocity^2

Kinetics

- KE of a car in motion that stops suddenly must be transformed or applied to another object.

Kinetics

- Other factors that will affect energy dissipation in a crash include:
  - Vehicle's angle of impact
  - Differences in sizes of the two vehicles
  - Restraint status and protective gear of occupants

Kinetics

- Law of conservation of energy
  - Energy can neither be created nor destroyed.
- Energy dissipation
  - Process by which KE is transformed into mechanical energy
  - Protective devices can manipulate the way in which energy is dissipated.

Kinetics

- Newton's first law of motion
  - A body at rest will remain at rest unless acted on by an outside force.
- Newton's second law of motion
  - The force an object can exert is the product of its mass times its acceleration.
  - Force = mass x acceleration (or deceleration)

Kinetics

- Rapid deceleration dissipates tremendous forces.
- Deceleration and acceleration can be measured in numbers of *g* force.
  - One *g* force = normal acceleration due to gravity

Multisystem Trauma

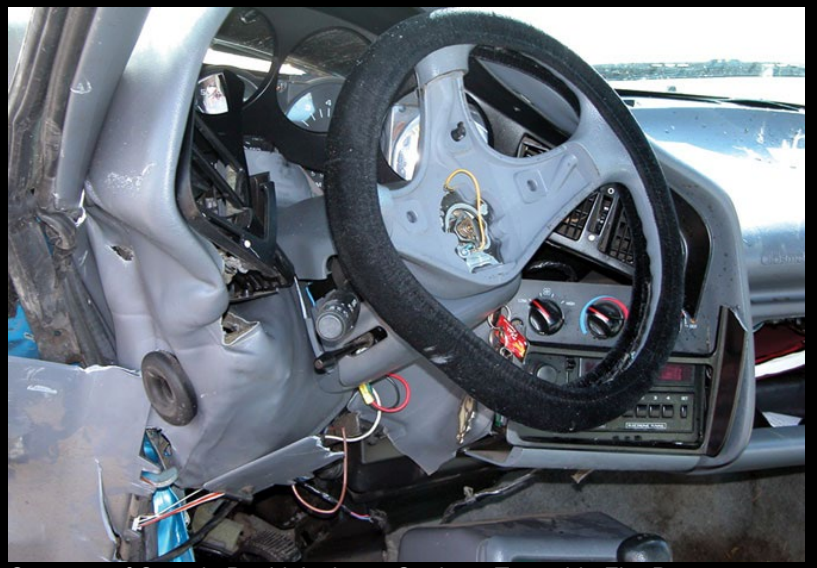
- Injuries that involve several body systems
- If you suspect multisystem trauma:
  - Assess the entire body.
  - Prioritize the treatment of the injuries.
  - Transport without delay.

Blunt Trauma

- Injuries in which tissues are not penetrated by external object

Motor Vehicle Crashes

- Five phases of trauma:
  - Phase 1: Deceleration of the vehicle
  - Phase 2: Deceleration of occupant



Courtesy of Captain David Jackson, Saginaw Township Fire Department.

Motor Vehicle Crashes

- Five phases of trauma (cont'd):
  - Phase 3: Deceleration of internal organs
  - Phase 4: Secondary collisions
  - Phase 5: Additional impacts received by the vehicle

Impact Patterns

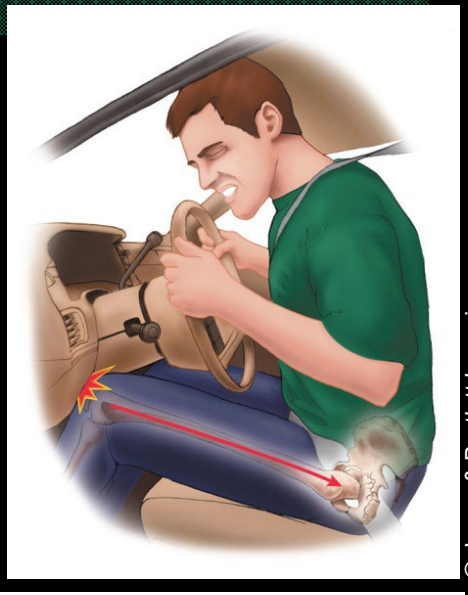
- Frontal or head-on impacts
  - Front end of the car distorts
  - Passengers decelerate at same rate as vehicle
  - Abrupt deceleration injuries are produced by a sudden stop of a body's forward motion.

Impact Patterns

- Frontal or head-on impacts (cont'd)
  - Common injuries
    - Head injuries
    - Torn aorta
    - Tearing or shearing injuries to internal organs
    - Crush and compression injuries

Impact Patterns

- Frontal or head-on impacts (cont'd)
  - Unrestrained occupants usually follow one of two trajectories:
    - Down-and-under pathway
    - Up-and-over pathway



Impact Patterns

- Lateral or side impacts
  - Impart energy to the near-side occupant
  - Seat belts offer little protection.
  - The body is pushed in one direction, while the head moves toward the impacting object.

Impact Patterns

- Rear impacts
  - Have the most survivors
  - Whiplash injury is common.
  - Energy is imparted to the front vehicle.

Impact Patterns

- Rotational or quarter-panel impacts
  - Occurs when a lateral crash is off center
  - The vehicle's forward motion stops, but the side continues in rotational motion.
  - Greatest damage occurs at point of vehicle's greatest loss of speed

Impact Patterns

- Rollovers
  - Patients may be ejected.
  - Patients may be struck hard against the interior of the vehicle.

Restrained Versus Unrestrained Occupants

- Seat belts stop the motion of an occupant traveling at the same speed as the vehicle.
  - Limit contact with the interior of the vehicle
  - Prevent ejection
  - Associated injuries include cervical fractures and neck sprains.

Restrained Versus Unrestrained Occupants

- Air bags have reduced deaths in direct frontal crashes by 30%.
  - Secondary injuries:
    - Direct contact
    - Chemicals

Motorcycle Crashes

- Any structural protection is derived from protective devices worn by the rider.
  - Helmet
  - Leather or abrasion-resistant clothing and boots

Motorcycle Crashes

- Attention should be given to:
  - Deformity of motorcycle
  - Side damaged
  - Distance of skid
  - Deformity of objects or vehicles
  - Helmet deformity

Motorcycle Crashes

- Four types of motorcycle impact:
  - Head-on impact
  - Angular impact
  - Ejection
  - Laying the bike down

Motorcycle Crashes

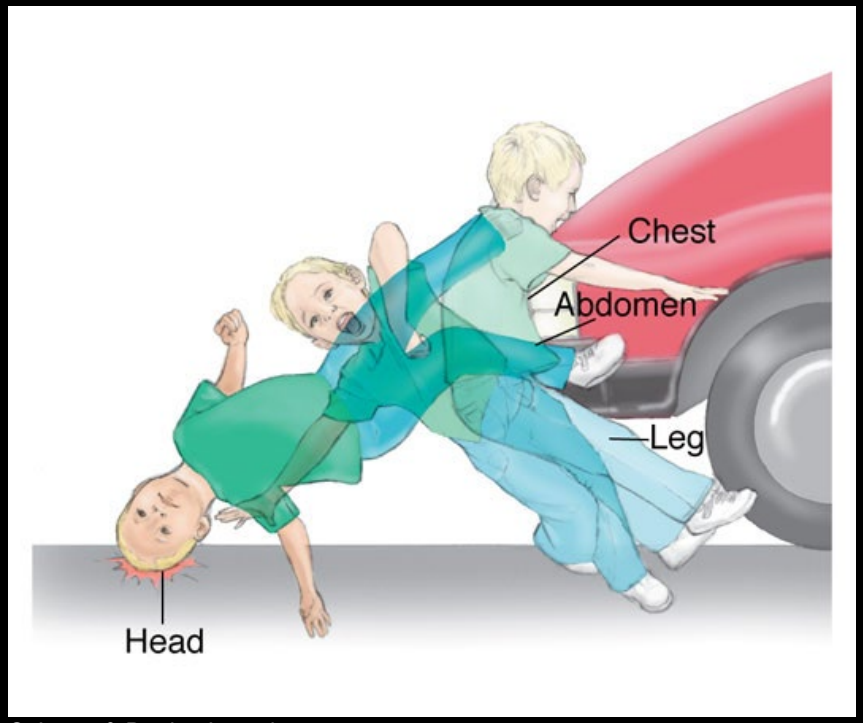
- Helmet should be removed carefully if:
  - Airway management techniques cannot be performed with the helmet in place.
  - Helmet does not fit snugly to the head.
- Helmet should be cut if it cannot be removed without further deformation.

Pedestrian Injuries

- Three predominant MOIs:
  - First impact
    - Auto strikes body with its bumpers.
  - Second impact
    - Adult is thrown on hood/grille of vehicle.
  - Third impact
    - Body strikes the ground or some other object.

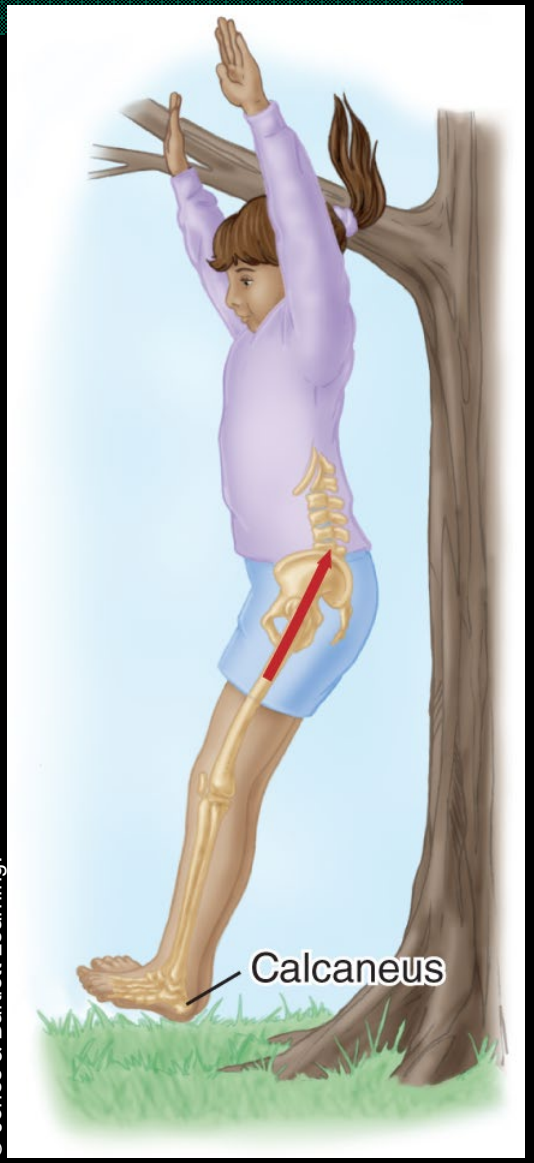
Pedestrian Injuries

- Waddell triad: Pattern of injuries in children and people of short stature



Falls from Heights

- Severity of injuries impacted by:
  - Height
  - Position
  - Area
  - Surface
  - Physical condition

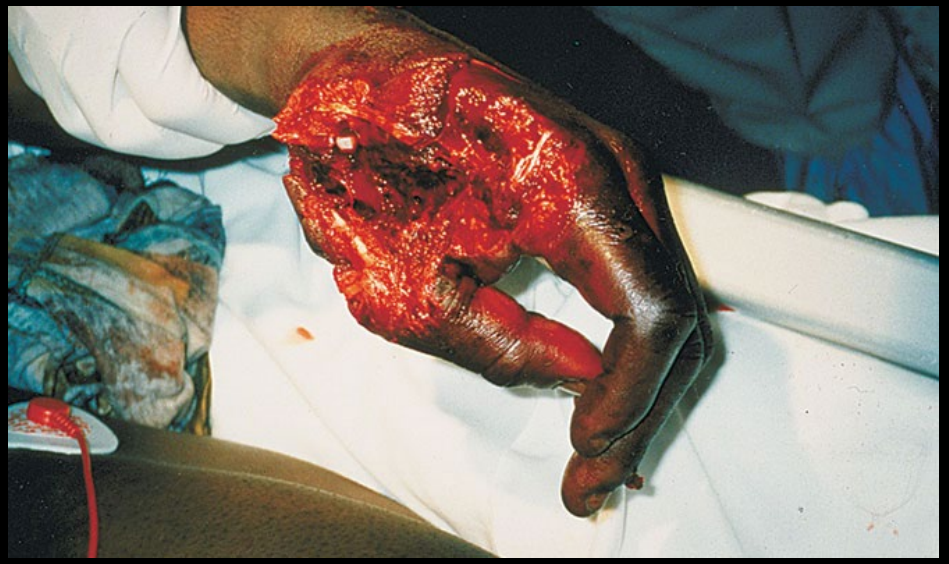


Penetrating Trauma

- Involves disruption of skin and tissues in a small, focused area
  - Low velocity
  - Medium and high velocity

Penetrating Trauma

- In the United States, the most common sources of penetrating injuries are firearms.



Stab Wounds

- Severity depends on:
  - Anatomic area involved
  - Depth of penetration
  - Blade length
  - Angle of penetration

Gunshot Wounds

- Severity depends on:
  - Type of firearm
  - Velocity of projectile
  - Physical design/size of projectile
  - Distance of victim from muzzle
  - Type of tissue struck

Gunshot Wounds

- Shotguns
- Rifles
- Handguns
  - Revolver
  - Pistol

Gunshot Wounds

- Ballistics
  - Study of non-powered objects in flight
  - Trajectory: Curve of bullet's travel path
- Automatic weapons
  - Fully automatic
  - Semi-automatic

Gunshot Wounds

- Most important factor for seriousness of wound is type of tissue involved.
- Entrance wounds
  - Characterized by effects of the initial contact and implosion

Gunshot Wounds

- Deformation/ tissue destruction is based on:
  - Density
  - Compressibility
  - Missile velocity
  - Missile fragmentation
- Projectile crushes tissue and creates a permanent cavity.

Gunshot Wounds

- Exit wounds occur when projectile's energy is not entirely dissipated.

Gunshot Wounds

- Shotgun wounds
  - Result of tissue impact by numerous projectiles
- Wounding potential depends on:
  - Powder charge
  - Size and number of pellets
  - Dispersion of the pellets

Gunshot Wounds

- Try to obtain the following:
  - Weapon used
  - Range fired
  - Bullet used
- Look for:
  - Powder residue around the wound
  - Entrance and exit wounds

Blast Injuries

- Primary blast injuries
  - Damage is caused by pressure wave generated by explosion.
  - Organs affected:
    - Lungs, eardrums, compressible organs
  - Close proximity to the origin of the pressure wave carries a high risk of injury or death.

Blast Injuries

- Secondary blast injuries
  - Result from being struck by flying debris
  - A blast wind occurs.
  - Flying debris may cause blunt and penetrating injuries.

Blast Injuries

- Tertiary blast injuries
  - Occur when a person is hurled against stationary, rigid objects
  - Ground shock
    - Physical displacement when the body impacts the ground

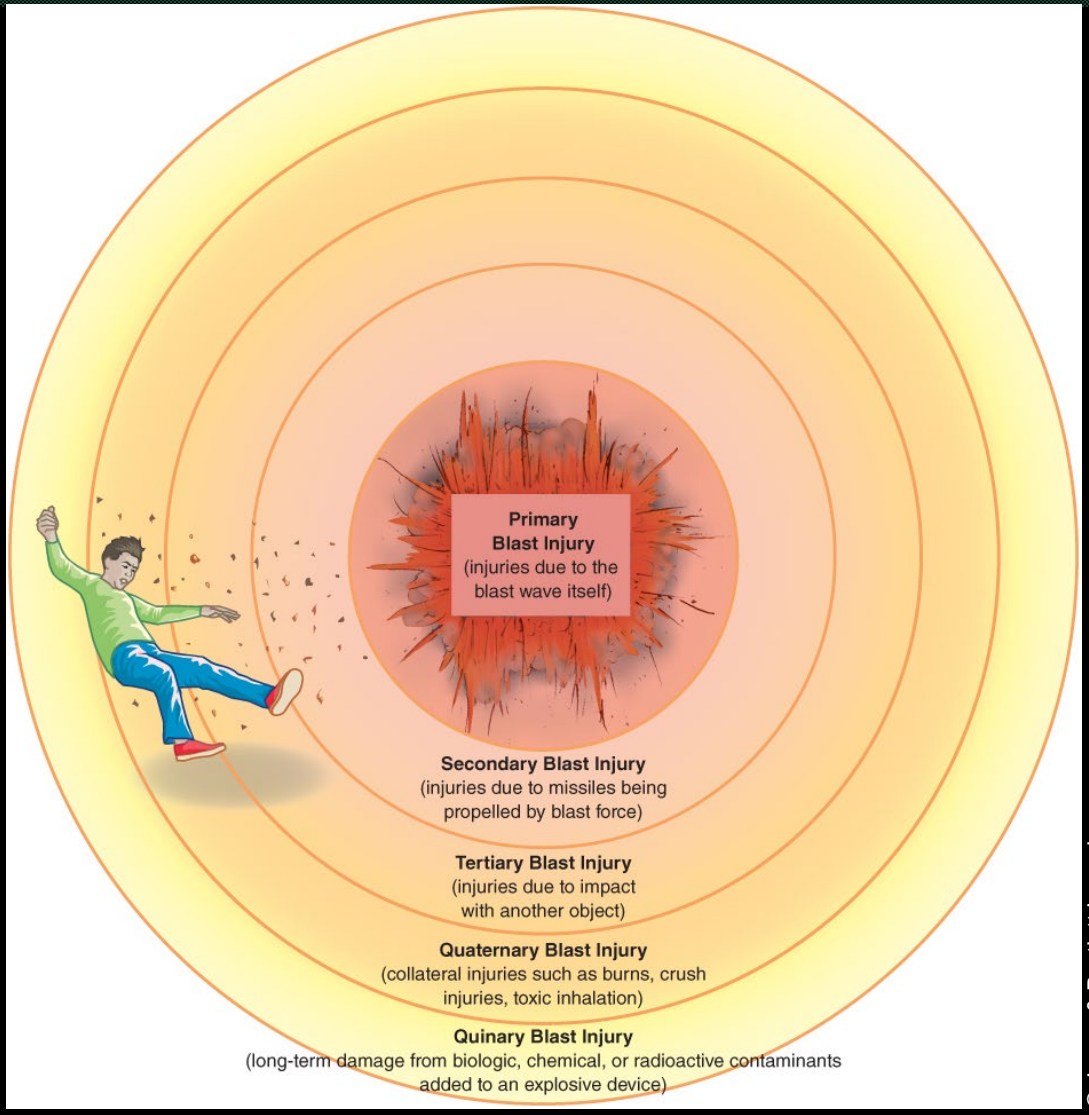
Blast Injuries

- Quaternary (miscellaneous) blast injuries
  - Occur from the miscellaneous events that occur during an explosion
  - May include:
    - Burns
    - Respiratory injury
    - Crush injury
    - Entrapment

Blast Injuries

- Quinary blast injuries
  - Caused by biologic, chemical, or radioactive contaminants added to an explosive
  - Associated with “dirty bombs”

Blast Injuries



Physics of an Explosion

- When a substance is detonated, it is converted into large volumes of gas under pressure.
- Propellants: Explosives designed to release energy slowly

Physics of an Explosion

- Blast front
- Positive wave pulse
- Shock wave
- Negative wave pulse

Physics of an Explosion

- Speed, duration, and pressure of the shock wave are affected by:
  - Size of the explosive charge
  - Nature of surrounding medium
  - Distance from explosion
  - Presence or absence of reflecting surfaces

Physics of an Explosion

- An explosion is more damaging in closed spaces.
- Blast pressures cause destruction at:
  - Interface between tissues of different densities
  - Interface between tissues and trapped air

Tissues at Risk

- Air-containing organs are more susceptible to pressure changes.
- Junctions between tissues of different densities and exposed tissues are prone.
- The ear is most sensitive.

Tissues at Risk

- Primary pulmonary blast injuries occur as contusions and hemorrhages.
  - Underlying pneumothorax
- If there is any reason to suspect lung injury in a blast victim, administer oxygen.

Tissues at Risk

- Solid organs may be injured by secondary missiles or a hurled body.
- Neurologic injuries and head trauma are the most common causes of death.
- Extremity injuries are common.

Tissues at Risk

- Assessment and management of blast injuries
  - If scene safety cannot be ensured, evacuate until advised that it is safe.
  - Assess for other hazards.
  - Form a general impression as you approach.

Tissues at Risk

- Assessment and management of blast injuries (cont'd)
  - Assess breath sounds frequently.
  - Examine for the presence of DCAP-BTLS.
  - Establish a baseline pulse oximetry value.
  - Do not assume the absence of abdominal injury based on the absence of overt signs.
  - Manage impaled objects according to guidelines.

Scene Size-Up

- Attention to PPE is required.
- Anticipate possible scene hazards.
- Assess your environment carefully.
- Consider whether you will need additional medical resources.

Primary Survey

- Form a general impression.
  - Keep the MOI in mind as you approach.
    - Consider whether spinal immobilization will be necessary.
  - Evaluate the patient using the AVPU.

Primary Survey

- Airway and breathing
  - If patient is unresponsive, open the airway using the jaw-thrust maneuver.
  - If necessary, remove foreign objects and suction out blood or vomitus.
  - Consider an oral or nasopharyngeal airway.

Primary Survey

- Airway and breathing (cont'd)
  - Once the airway is clear, assess breathing.
  - Note the skin color.
  - Observe chest wall movement.

Primary Survey

- Airway and breathing (cont'd)
  - Assess the thorax and neck for:
    - Deviated trachea
    - Tension pneumothorax
    - Neck and chest crepitation
    - Broken ribs
    - Fractured sternum
    - Other problems that may inhibit breathing

Primary Survey

- Circulation
  - Check radial and carotid pulses simultaneously.
    - If there is no pulse, begin CPR.
  - Skin condition can also be a good indicator.
  - Scan for significant external bleeding.

Primary Survey

- Assess for disability.
  - GCS score
  - Pupil size, equality, and reactivity to light
  - Evaluate pulse, motor and sensation in extremities
- Expose the patient for exam.
  - Scan for life-threats.
  - Manage life-threats as you find them.

Primary Survey

- Transport decision
  - Immediate transport include patients with:
    - Altered mental status
    - Airway or breathing problems
    - Multisystem trauma
    - Significantly compromised circulation

Primary Survey

- Transport decision (cont'd)
  - If a patient needs immediate transport, continue your assessment en route to the trauma center.
  - On-scene time should be limited to 10 minutes.
    - "Platinum 10 minutes"

History Taking

- Obtain a SAMPLE history and OPQRST.
- Important information to obtain includes:
  - Allergies
  - Medications
  - Past medical history
  - Patient's last oral intake
  - Events leading up to the situation

Secondary Assessment

- Two major groups of trauma patients:
  - Isolated injury
  - Multisystem trauma
    - Find all the various problems, then prioritize them by severity and order in which you plan to address them.

Secondary Assessment

- Vital signs
  - Obtain a full set of initial or baseline vital signs.
  - Should include an assessment of:
    - Pulse
    - Respirations
    - Auscultatory blood pressure

Secondary Assessment

- Physical examinations
  - Most patients should have a thorough physical exam prior to or during transport.
  - Head-to-toe exam should be done in a systematic manner.

Secondary Assessment

- Head and neck
  - Palpate and visualize for injuries.
  - Check nose, mouth, and ears for bleeding.
  - Check for jugular vein distension and tracheal deviation.
- Chest, abdomen, and pelvis
  - Inspect and palpate chest wall.
  - Listen to breath and heart sounds.
  - Palpate the abdomen.
  - Palpate the iliac crests.

Secondary Assessment

- Extremities
  - Palpate the legs from top to bottom.
  - Check both feet for:
    - Distal pulse
    - Motion
    - Sensation
  - Examine the arms.
- Back
  - While the patient is on his or her side, examine the back for injuries.

Reassessment

- Repeat the primary survey.
- Reevaluate vital signs.
- Review the status of the interventions.
- Notify the hospital staff.

Trauma Score

- Used to determine the likelihood of survival
- Takes into account:
  - Glasgow Coma Scale (GCS) score
  - Respiratory rate
  - Respiratory expansion
  - Systolic blood pressure
  - Capillary refill

Trauma Score

- GCS
  - Evaluation tool used to determine level of consciousness
  - Scores are assigned for eye opening, verbal response, and motor response.
  - Does not accurately predict survivability in patients with severe head injuries

Revised Trauma Score

- Used to assess injury severity in patients with head trauma
- Data used to calculate the score include:
  - GCS score
  - Systolic blood pressure
  - Respiratory rate
- Highest score is 12; lowest is 0.

Revised Trauma Score

Table 29-4 Revised Trauma Score Calculation

GCS Score	Systolic Blood Pressure (mm Hg)	Respiratory Rate (breaths/min)	Value
13 to 15	>89	10 to 29	4
9 to 12	76 to 89	>29	3
6 to 8	50 to 75	6 to 9	2
4 to 5	1 to 49	1 to 5	1
3	0	0	0

Abbreviation: GCS, Glasgow Coma Scale

Data from: Table 1, Triage Revised Trauma Score (T-RTS). *Int Journal Emerg Med.* 2008;1(1):21-26. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2536180/table/Tab1/. Published online March 15, 2008. Accessed April 7, 2016.

Management of Trauma

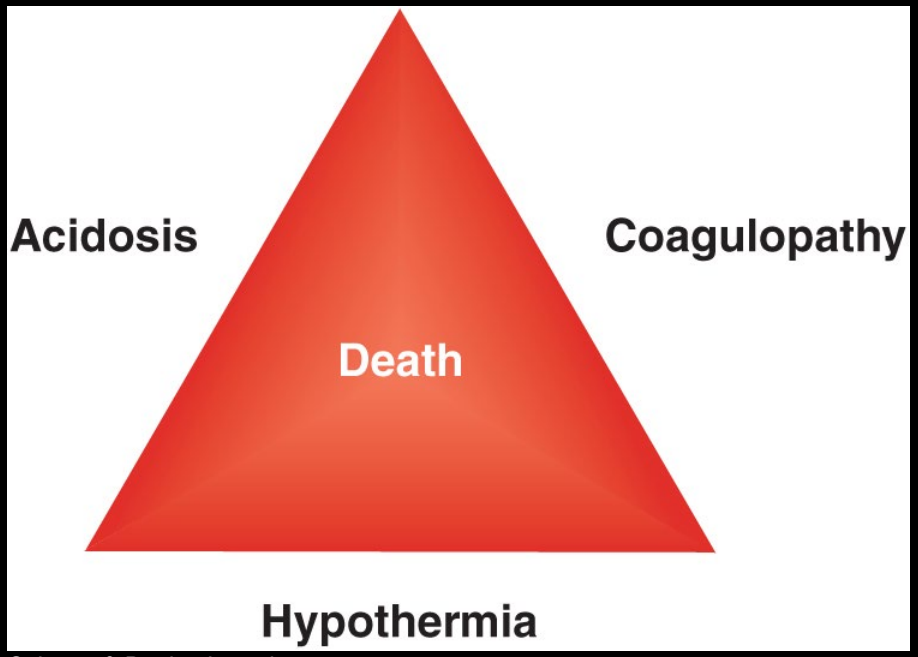
- During transport, begin interventions.
- Most trauma patients will need to be treated for shock.
  - Give oxygen.
  - Keep supine with extremities slightly elevated.
  - Transport rapidly to a trauma center.

Management of Trauma

- Consider fluid resuscitation.
  - Consult with medical control.
  - Begin fluid resuscitation at volumes that maintain a minimum blood pressure.
- Several techniques can be used.
  - Use a team approach.
  - Critical thinking is important.

Trauma Lethal Triad

- Hypothermia
- Coagulopathy
- Acidosis



Criteria for Referral to a Trauma Center

- Physiologic criteria
  - GCS score of less than or equal to 13
  - SBP of less than 90 mm Hg
  - Respiratory rate of less than 10 or more than 29 breaths/min or need for ventilator support

Criteria for Referral to a Trauma Center

- Anatomic criteria
  - Penetrating trauma to head, neck, torso, and extremities
  - Chest wall instability or deformity
  - Two or more proximal long bone fractures
  - Crushed, mangled, or pulseless extremity
  - Amputation proximal to wrist or ankle
  - Pelvic fractures
  - Open or depressed skull fractures
  - Paralysis

Criteria for Referral to a Trauma Center

- MOI criteria
  - Adults: Falls more than 20 ft
  - Children: Falls more than 10 ft
  - High-risk auto crash
  - Pedestrian/bicyclist thrown or run over
  - Motorcycle crash at more than 20 mph

Criteria for Referral to a Trauma Center

- Special considerations
  - Patient's age is more than 55 years.
  - Systolic blood pressure of less than 110 mm Hg in persons older than 65 years
  - Children triaged to a pediatric-capable center.
  - Patient uses anticoagulants or has a bleeding disorder.
  - Patient is pregnant.
  - Low-impact mechanism in older adults
  - Burns with other trauma
  - EMS provider judgment

Criteria for Referral to a Trauma Center

- The ACS-COT defines four separate levels of trauma centers (Level I, II, III, and IV).
- Give the trauma center early notice of the patient's arrival.

Criteria for Referral to a Trauma Center

Table 29-6 Key Elements for Trauma Centers

Level	Definition	Key Elements
Level I	A comprehensive regional resource that is a tertiary care facility. Capable of providing total care for every aspect of injury—from prevention through rehabilitation	1. 24-hour in-house coverage by general surgeons 2. Availability of orthopaedic surgery, neurosurgery, anesthesiology, emergency medicine, radiology, internal medicine, and critical care 3. Should also include cardiac, hand, pediatric, and microvascular surgery, as well as hemodialysis 4. Provides leadership in prevention, public education, and continuing education of trauma team members 5. Committed to continued improvement through a comprehensive quality assessment program and organized research to help direct new innovations in trauma care
Level II	Able to initiate definitive care for all injured patients	1. 24-hour immediate coverage by general surgeons 2. Availability of orthopaedic surgery, neurosurgery, anesthesiology, emergency medicine, radiology, and critical care 3. Tertiary care needs such as cardiac surgery, hemodialysis, and microvascular surgery may be referred to a Level I trauma center 4. Committed to trauma prevention and continuing education of trauma team members 5. Provides continued improvement in trauma care through a comprehensive quality assessment program
Level III	Able to provide prompt assessment, resuscitation, and stabilization of injured patients and emergency operations	1. 24-hour immediate coverage by emergency medicine physicians and prompt availability of general surgeons and anesthesiologists 2. Program dedicated to continued improvement in trauma care through a comprehensive quality assessment program 3. Has developed transfer agreements for patients requiring more comprehensive care at a Level I or Level II trauma center 4. Committed to continuing education of nursing and allied health personnel or the trauma team 5. Must be involved with prevention and have an active outreach program for its referring communities
Level IV	Able to provide ATLS before transfer of patients to a higher level trauma center	1. Include basic ED facilities to implement ATLS protocols and 24-hour laboratory coverage 2. Transfer to higher level trauma centers follows the guidelines outlined in formal transfer agreements 3. Committed to continued improvement of these trauma care activities through a formal quality assessment program 4. Involved in prevention, outreach, and education within its community

Abbreviations: ATLS, Advanced Trauma Life Support; ED, emergency department

Mode of Transport

- When deciding to transport by ground, consider:
  - Time
  - Extent of injuries
  - Landing zone

Courtesy of Mark Woolcock.

Mode of Transport

- Criteria for use of air medical services:
  - There is an extended period required to access or extricate a remote or trapped patient.
  - Distance to the trauma center is greater than 20 to 25 miles.
  - Patient needs ALS, and no ALS-level ground ambulance service is available.

Mode of Transport

- Criteria for use of air medical services (cont'd):
  - Traffic conditions or hospital availability make it unlikely that the patient will get to a trauma center within the ideal time frame.
  - There are multiple patients who will overwhelm resources at the trauma center(s).

Mode of Transport

- Criteria for use of air medical services (cont'd):
  - EMS systems require the patient be brought to the nearest hospital.
  - There is a mass-casualty incident.

Mode of Transport

- When making the transport decision, consider:
  - Ground transport time
  - Air transport time
  - Terrain

Research and Trauma Care

- The military has done extensive research regarding trauma patient care.
  - Pneumatic anti-shock garments
  - Tourniquet use
- Only evidence-based treatments should be adopted for widespread use.

Thank You

Please move to the next section