Chapter 37
Trauma Overview and Mechanism of Injury

Learning Objectives
• Describe the incidence and scope of traumatic injuries and deaths.
• Identify the role of each component of the trauma system.
• Predict injury patterns based on knowledge of the laws of physics related to forces involved in trauma.
Learning Objectives

- Describe injury patterns that should be suspected when injury occurs related to a specific type of blunt trauma.
- Describe the role of restraints in injury prevention and injury patterns.
- Discuss how organ motion can contribute to injury in each body region depending on the forces applied.

Learning Objectives

- Identify selected injury patterns associated with motorcycle and all-terrain vehicle collisions.
- Describe injury patterns associated with pedestrian collisions.
- Identify injury patterns associated with sports injuries, blast injuries, and vertical falls.
- Describe factors that influence tissue damage related to penetrating injury.

Epidemiology of Trauma

- Unintentional injury is devastating medical and social problem
  - Leading cause of death among persons 1 to 44 years of age
  - Fifth leading cause of death among all Americans
  - Trauma deaths in 2006 were exceeded only by heart disease, cancer, stroke, and chronic lower respiratory diseases
  - In 2006, about 120,000 unintentional injury deaths occurred in United States
  - National Safety Council estimates that total number of unintentional injuries in United States approaches 61 million annually
Trends in Trauma Deaths

- Deaths from unintentional injury are increasing yearly
  - Most deaths from trauma can be prevented
  - Increase in deaths points to need for increased safety and health efforts to reverse trend
  - After motor vehicle crashes, poisoning by solids and liquids, falls, fire and flames, drowning, and choking have been the top 5 causes of trauma deaths since 1970

Trauma Systems

- Comprehensive trauma system consists of many different components
  - Integrated and coordinated to provide cost-effective services for injury prevention and patient care
  - At center of this system is continuum of care, which includes
    - Injury prevention
    - Prehospital care
    - Acute care facilities
    - Post-hospital care
Trauma Systems

- Sampling of these components
  - Injury prevention
  - Prehospital care, including management, transportation, and trauma triage guidelines
  - Emergency department care
  - Interfacility transportation if needed
  - Definitive care
  - Trauma critical care
  - Rehabilitation
  - Data collection and trauma registry

What other measures will you take, while on duty as a paramedic, to decrease the risk of traumatic injury to your or your coworkers?

Trauma Systems

- Paramedic plays crucial role in trauma system
  - One aspect of this role is being involved in injury prevention programs
  - Another aspect includes entering appropriate patients into trauma care system while providing appropriate patient care
  - Fulfills this role by taking part in data collection and research
  - Research can influence health care improvements in caring for injured patients
Trauma Centers

• U.S. Department of Health and Human Services released Position Paper on Trauma Center Designation in 1980
  – Since then, states have developed comprehensive trauma systems
  – As of 2010, 225 hospitals have designated specialty in trauma

Trauma Centers

• American Medical Association recommended categorization of hospital emergency services in early 1970s
  – In 1990 (revised in 1999), Task Force of the American College of Surgeons (ACS) Committee on Trauma published Resources for Optimal Care of Injured Patient
  – Paper described three levels of trauma centers
    • Levels are based on resources (essential and desired), admissions, staff, research, and education involvement

Trauma Centers

• Level I trauma center
  – Has full range of specialists and equipment available 24 hours a day
  – Admits minimum required annual volume of severely injured patients
  – Has program of research
  – Leader in trauma education and injury prevention
  – Referral resource for communities in neighboring regions through community outreach
Trauma Centers

• Level I trauma center
  – Must have program for substance abuse screening
    • Provide brief intervention to patients as appropriate
  – Can provide total care for every aspect of injury
  – Assignment of category to trauma center also enables EMS personnel to transport patients rapidly to most appropriate facility

Trauma Centers

• Other specialized care facilities provide care for critically ill or injured patients with special needs
  – Pediatric trauma centers
  – Burn centers
  – Hyperbaric centers
  – Poison treatment centers

Trauma Centers

• ACS Committee on Trauma also established guidelines for
  – Field triage
  – Interhospital triage to specialized care facilities
  – Mass casualty triage
• Criteria are based on
  – Patient’s condition
  – Mechanism of injury
  – Injury severity indexes
  – Available patient care resources
Where can you find the trauma triage criteria for your area?

Transportation Considerations

• Determining proper level of care and hospital destination is based on
  – Patient’s needs
  – Condition
  – Sometimes advice of medical direction
• Once paramedic determines level of care needed and destination facility, decisions can be made about mode of transportation
Ground Transportation

• As a rule, paramedic should use ground transportation by ambulance if appropriate facility can be reached within “reasonable time”
  – Reasonable time is defined by national standards (e.g., definitive care within 60 minutes after injury for severe trauma) and local protocol

Ground Transportation

• Factors that affect decision to use ground or air transportation
  – Geographical location
  – Topographical area
  – Population
  – Weather
  – Availability of resources
  – Traffic conditions
  – Time of day

Aeromedical Transportation

• Availability and use of aeromedical services varies throughout United States
  – Aeromedical services can provide
    • Rapid response time
    • High-quality medical care
    • Rapid transportation to appropriate care facilities
    • Aerial surveillance and transportation of additional personnel and equipment to emergency scene
  – Paramedic crews should consult with medical direction and follow local protocol regarding use of aeromedical services
Aeromedical Transportation

• Consider air transportation in following situations
  – Time needed to transport patient by ground to appropriate facility poses threat to patient’s survival and recovery
  – Weather, road, or traffic conditions would seriously delay patient’s access to definitive care
  – Critical care personnel and equipment are needed to adequately care for patient during transportation

Energy

• Transfer of energy from external source to human body causes injuries
  – Extent of injury determined by
    • Type and amount of energy applied
    • How quickly energy is applied
    • Part of body to which energy is applied

Physical Laws

• Knowledge of four basic laws of physics is required to understand wounding forces of trauma
  – Newton’s first law of motion
    • An object, whether at rest or in motion, remains in that state unless acted upon by an outside force
  – Conservation of energy law
    • Energy cannot be created or destroyed
    • Can only change form
Physical Laws

• Knowledge of four basic laws of physics is required to understand wounding forces of trauma
  – Newton’s second law of motion: Force (F) equals mass (M) multiplied by acceleration (a) or deceleration (d)
    \[ F = M \times a \text{ or } F = M \times d \]
  – Kinetic energy: Kinetic energy (KE) equals half the mass (M) multiplied by velocity squared (V^2)
  – Velocity is much more critical than mass in determining total kinetic energy

Can you apply these same four laws of physics to another traumatic situation, such as a fall onto concrete? What force is applied? What factors influence the kinetic energy?

Kinematics

• Kinematics is process of predicting injury patterns
  – Specific types and patterns of injuries are associated with certain mechanisms
  – In addition to individual factors and protective factors, consider the following when evaluating trauma patients
    • Mechanism of injury
    • Force of energy applied
    • Anatomy
    • Energy

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Blunt Trauma

- Blunt trauma is injury produced by wounding forces of compression and change of speed (usually deceleration)
  - Forces can disrupt tissue
  - Direct compression
    - Pressure on structure
    - Most common type of force applied in blunt trauma

- Amount of injury depends on
  - Length of time of compression
  - Force of compression
  - Area compressed

- Example
  - Compression of thorax can lead to rib fracture or pneumothorax

- Other compression injuries
  - Contusions and lacerations of solid organs
  - Rupture of hollow (air-filled) organs
Blunt Trauma

- Acceleration
  - Increase in velocity of moving object
- Deceleration
  - Decrease in velocity of moving object
- Both can produce major injury
- Example
  - Car that comes to stop abruptly—occupant’s body continues its constant velocity after impact until it decelerates as result of striking steering wheel, restraint system, or dashboard

Blunt Trauma

- External aspect of body is stopped forcibly
  - Contents of cranial, thoracic, and peritoneal cavities remain in motion because of inertia
  - As a result, tissues can be stretched, crushed, ruptured, lacerated, or sheared from their points of attachment
  - Examples of injuries caused by change of speed
    - Concussion
    - Cardiac or pulmonary contusion
    - Organ laceration
    - Aortic tear

Motor Vehicle Collision

- Various injuries produced by blunt trauma are illustrated best through examination of vehicle collisions
- Forces that cause blunt trauma can result from variety of impacts
Motor Vehicle Collision

- Vehicle collision involves three separate impacts as energy is transferred
  - In first impact, vehicle strikes an object
  - In second, occupant collides with inside of car
  - In third, internal organs collide inside body
- Injuries that result depend on type of collision and position of occupant inside vehicle
- Injuries also depend on use or nonuse of active or passive systems

Head-On (Frontal) Impact

- Head-on collisions result when forward motion stops abruptly
  - First collision occurs when vehicle hits second vehicle, resulting in damage to front of car
    - As vehicle abruptly stops, occupant continues to move at speed of vehicle before impact
  - Front seat occupant continues forward into restraint system, steering column, or dashboard
    - Results in second collision

Head-On (Frontal) Impact

- Head-on collisions result when forward motion stops abruptly
  - Occupant who is not restrained usually travels in one of two pathways in relationship to dashboard
    - Down-and-under
    - Up-and-over
    - Precise course of pathway determines how organs collide inside body and extent of tissue damaged
Head-On (Frontal) Impact

• Down-and-under pathway
  – Occupant travels downward into vehicle seat and forward into dashboard or steering column
  – Knees become leading part of body, striking dashboard
  – Upper legs absorb most of impact

Head-On (Frontal) Impact

• Down-and-under pathway
  – Predictable injuries
    • Knee dislocation
    • Patellar fracture
    • Femoral fracture
    • Fracture or posterior dislocation of hip
    • Fracture of acetabulum, vascular injury, hemorrhage

Head-On (Frontal) Impact

• Down-and-under pathway
  – After initial impact of knees into dashboard, body rotates forward
    • As chest wall hits steering column or dashboard, head and torso absorb energy as indicated in description of up-and-over pathway
How does the use of lap and shoulder restraints influence the patterns of injury described here? (up-and-over, down-and-under pathways)

Head-On (Frontal) Impact

- In up-and-over pathway, body in forward motion strikes steering wheel
  - As this occurs, ribs and underlying structures absorb momentum of thorax
  - Predictable injuries from this transfer of energy
    - Rib fracture
    - Ruptured diaphragm
    - Hemopneumothorax
    - Pulmonary contusion
    - Cardiac contusion
    - Myocardial rupture
    - Vascular disruption (most notably aortic rupture)
Head-On (Frontal) Impact

• If abdomen is point of impact, compression injuries can occur to
  – Hollow abdominal organs
  – Solid organs
  – Lumbar vertebrae
  – Kidneys, liver, and spleen are subject to vascular tears from supporting tissue
    • Tearing of renal vessels from their points of attachment to inferior vena cava and descending aorta

Head-On (Frontal) Impact

• Predictable injuries
  – Liver laceration
  – Spleen rupture
  – Internal hemorrhage
  – Abdominal organ incursion into thorax (ruptured diaphragm)
Head-On (Frontal) Impact

- If head absorbs most of impact, cervical vertebrae take up continued momentum of body
  - Cervical flexion, axial loading, hyperextension can result in fracture or dislocation of cervical vertebrae
  - Severe angulation of cervical vertebrae can damage soft tissues of neck
  - May cause spinal cord injury and spinal instability, even without fracture

Head-On (Frontal) Impact

- Other predictable injuries
  - Trauma to brain (e.g., concussion, contusion, shearing injury, and edema)
  - Disruption of vessels inside head (intracranial vascular disruption),
  - Resulting in subdural or epidural hematoma

Lateral Impact

- Occurs when vehicle is struck from side
  - Injury patterns depend on whether damaged vehicle remains in place or moves away from point of impact
  - External shell of vehicle that remains in place after impact usually intrudes into passenger compartment and usually directs force at lateral aspect of person's body
  - Predictable injuries result from compression to torso, pelvis, and extremities
Lateral Impact

• Examples of these injuries
  – Fractured ribs
  – Pulmonary contusion
  – Ruptured liver or spleen (depending on side involved)
  – Fractured clavicle
  – Fractured pelvis
  – Head and neck injury
• Vehicles that have side-impact air bags can guard against injury in some lateral impacts

Lateral Impact

• If damaged vehicle moves away from point of impact, occupant accelerates away from point of impact
  – Occupant moves laterally with car
  – Effects of inertia on head, neck, thorax produce lateral flexion and rotation of cervical spine
  – Movement can result in neurological injury

Lateral Impact

• Flexion and rotation of cervical spine
  – Movement can result in neurological injury
  – Such movement also can result in tears or strains of lateral ligaments and supporting structures of neck
  – Injuries also can occur on side of passenger opposite impact as occupant is propelled toward other side of car
  – If other occupants are in vehicle, secondary collision with other passengers is likely
Rear-End Impact

• Vehicle that is struck from behind rapidly accelerates, causing it to move forward under occupant
  – Greater the difference in forward speed of two vehicles, greater the force and damaging energy of initial impact

Rear-End Impact

• Damaging energy is greater than when vehicle going 50 mph hits vehicle going 30 mph
  – In forward collisions, sum of speeds of both vehicles is velocity that produces damage
  – In rear-end collisions, difference between the two speeds is damaging velocity

Rear-End Impact

• Predictable injuries in rear-end collisions
  – Back and neck injuries
  – Cervical strain or fracture caused by hyperextension
  – Cervical portion of spine is susceptible to secondary hyperextension caused by rapid forward acceleration of vehicle and subsequent relative rearward movement of occupant
  – If vehicle collides with object in front of it, suspect injuries associated with frontal impact
Rotational Impact

- Occur when off-center portion of vehicle (usually front quarter) strikes an immovable object or one that is moving more slowly or in opposite direction
  - Part of vehicle striking object stops during impact
  - Rest of vehicle continues in forward motion until energy is transformed completely

Rotational Impact

- Occupant moves inside vehicle with forward motion
  - Occupant usually is struck by side of car as vehicle rotates around point of impact
  - Rotational impact results in injuries common to head-on and lateral collisions

Rollover Crashes

- In rollover crashes or collisions, person tumbles inside vehicle
  - Occupant is injured wherever his or her body strikes vehicle
  - Various impacts occur at many different angles, which can cause multiple-system injuries
  - Predicting injury patterns from rollover collisions is difficult
  - Crashes can produce any injury patterns associated with other types of collisions
Restraints

• In recent years, public awareness programs and various state laws have increased use of personal restraints
  – According to National Safety Council, among passenger vehicle occupants over 4 years of age, safety belts saved estimated 15,383 lives in 2006
  – Another 5,541 lives could have been saved if all passengers over 4 years of age had worn safety belts
  – At this time, states and the District of Columbia have child safety seat laws
  – 49 states and District of Columbia have mandatory belt use laws in effect (one exception is New Hampshire)

Restraints

• Serious hazard to unrestrained occupants is ejection from vehicle after impact
  – Among crashes in which fatality occurred in 2005, only 1 percent of restrained passenger car occupants were ejected, compared with 31 percent of those who were unrestrained

Restraints

• In addition, 1 of every 13 ejection victims suffers spinal fracture, and ejected victims are killed 6 times more often than those who are not ejected
  – Mortality rate among ejected victims is high
    • Results in part from occupant being subjected to a second impact as body strikes ground or another object outside vehicle
How can you apply this knowledge about ejection statistics to your practice in each of the phases of trauma care (preincident, incident, and postincident)?

Restraints
- Four restraining systems are available in the United States
  - Lap belts
  - Diagonal shoulder straps
  - Air bags
  - Child safety seats
- All these restraints significantly reduce injuries
  - If used inappropriately, can produce injuries

Lap Belts
- Used alone or with shoulder strap, most commonly used active restraint system
  - Person should direct lap belt at a 45-degree angle to floor between anterior-superior iliac spine and femur
  - Worn tightly enough to stay in this position absorbs energy forces
  - Belt protects abdominal cavity by transferring energy to strong, bony pelvis
Lap Belts

- Often worn incorrectly
  - If lap belt is worn above anterior-iliac spine, forward motion of body during impact is absorbed by vertebrae T12, L1, and L2
  - As thorax is propelled forward, abdominal organs are compressed between vertebral column and lap belt
    - Compression can cause injury to liver, spleen, duodenum, pancreas
    - Sign of these abdominal injuries is abrasions or lap belt imprint over abdomen

Lap Belts

- Major injury can result even when person uses lap belt correctly
  - Occur from angulation of lumbar spine, pelvis, thorax, head around restraint system
  - Injuries also occur from failure of restraint system to decrease impact forces
Lap Belts

• Major injury can result even when person uses lap belt correctly
  – Examples of injuries that can occur during high-speed impacts
    • Sternal fractures
    • Chest wall injuries
    • Lumbar vertebral fractures
    • Head injuries
    • Maxillofacial trauma

Diagonal Shoulder Straps

• Use of shoulder strap helps absorb forward motion of thorax after impact
  – When person wears shoulder strap with lap belt, shoulder strap prevents thorax, face, and head from striking dashboard, windshield, or steering column
  – Clavicular fracture can result from position of shoulder strap
  – Organ collision inside body can occur during high-speed impacts, even when personal restraint systems are used
    • Internal organ injury
    • Cervical fracture
    • Spinal cord injury still

Air Bags

• Some vehicles are equipped to protect against impacts
  – Side-impact air bags
  – Curtain air bags
  – Knee air bags
  – Safety belt air bags
  – Rear-curtain air bags
• More common air bag is frontal air bag that inflates from center of steering wheel and from dashboard during frontal impact
  – Cushions forward motion of occupant when used with lap and shoulder belt
Air Bags

• Frontal air bags deflate rapidly
  – Effective only with initial frontal and near-frontal collisions
  – Ineffective in multiple collisions, rear-impact collisions, lateral or rollover impacts
  – Do not prevent movement in down-and-under pathway
  – Occupant’s knees still may be point of impact
  – May result in leg, pelvis, abdominal injuries

Air Bags

• Air bag can produce significant injury if deployed in proximity (10 inches or closer) to occupant
  – Deployment in these situations can produce
    • Spinal fractures
    • Hand and eye injury
    • Facial and forearm abrasions

Air Bags

• Air bag can produce significant injury if deployed in proximity (10 inches or closer) to occupant
  – Following groups at higher risk of injury from air bag deployment
    • Infants and children less than 12 years of age
    • Adults of short stature (less than 5 ft 2 in)
    • Older adults
    • Persons with special medical conditions
Air Bags

- Most air bag injuries are minor cuts, bruises, or abrasions
  - Far less serious than head, neck, and chest injuries that air bags prevent
  - According to National Highway Traffic Safety Administration, frontal air bags saved more than 28,000 lives in 2009
  - However, deaths do sometimes occur from air bag deployment
    - Most are result of occupant being too close to air bag when it deployed

Air Bags

- Problem occurred more commonly from child not being restrained adequately with lap/shoulder devices or child safety seats during pre-crash braking
  - To protect against injury from air bag deployment, driver should be positioned at least 10 inches from air bag cover
    - Front seat passenger should be positioned at least 18 inches away from air bag cover
    - Children under 12 years of age should always ride in back seat and be in proper restraint device for their size

Child Safety Seats

- Leading cause of death in children less than 4 years of age is injuries sustained in motor vehicle crashes
  - For each of these deaths, U.S. Department of Health, Education, and Welfare estimates that thousands more suffer debilitating injury
  - National Center for Statistics and Analysis reports that an estimated 4,877 lives were saved by child restraints between 1975 and 1998
    - 425 lives were saved by child restraints in 2006 alone
Child Safety Seats

- Child safety seats come in several shapes and sizes
  - Variety accommodates different stages of physical development
  - Seats include infant carriers, booster seats, and toddler seats
    - Child safety seats use combination of lap belts, shoulder belts, full-body harnesses, harness-and-shield apparatus to protect child during vehicle collision

Child Safety Seats

- Predictable injuries likely to occur even with appropriate use of child safety seats
  - Blunt abdominal trauma
  - Change-of-speed injuries from deceleration forces
  - Neck and spinal injury
- Large amount of misuse of child safety seats occurs
  - Public education on correct use of child safety seats is key prevention measure

Organ Collision Injuries

- Organs can be injured as result of movement caused by deceleration and compression forces
  - Maintain high degree of suspicion regarding injuries to organs based on principles of kinematics
Deceleration Injuries

- When body organs are put into motion after an impact, continue to move
  - Move in opposition to structures that attach them to body
  - Risk exists of separation of body organs from their attachments
  - Injury to vascular pedicle or mesenteric attachment can lead to brisk or exsanguinating hemorrhage

Head Injuries

- When head strikes a stationary object, cranium comes to abrupt stop
  - Brain tissue inside cranium continues to move
  - Brain moves until it is compressed against skull
    - Can cause brain tissue to be bruised, crushed, lacerated

- Movement can cause blood vessels attached to brain and skull to be torn, producing intracranial hemorrhage
  - Other injuries associated with deceleration of head include central nervous system injury, caused by stretching of spinal cord and its attachments, and cervical fracture
Thoracic Injuries

- Aorta often is injured by severe deceleration forces
  - Aorta is affixed at several points
  - Proximally aorta is affixed by aortic valve in descending portion of aorta arch by ligamentum arteriosum
  - Descending aorta attached to thoracic spine
    - As thorax hits stationary object, heart and aorta continue in motion
    - Motion is in opposition to their attachment at lower end of aortic arch

- Aorta usually is sheared at level of its ligamentum arteriosum attachment
  - Frank rupture of aorta leads to rapid exsanguination
  - Transection and dissection through to internal lining (intima and media of aorta) can tamponade
    - Can allow patients to arrive at emergency department and survive injury
Abdominal Injuries

- When deceleration forces are applied to abdomen, intra-abdominal organs and retroperitoneal structures (most commonly the kidneys) are affected
  - Forward motion of kidneys can shear them away from their vascular pedicle attachments
  - Forward motion of small and large intestines can result in mesenteric tears

Abdominal Injuries

- Downward and forward motion of liver can cause separation at its midpoint from its vascular and hepatic duct pedicle
- Spleen is restrained by diaphragm and abdominal wall attachments
  - Forward motion of spleen can result in tear of splenic capsule
Head Injuries

• Compression injuries to head can result in
  – Open fractures
  – Closed fractures
  – Bone fragment penetration (depressed skull fracture)
    • Associated injuries include brain contusion and lacerations of brain tissue
  – Compression forces to skull also can produce hemorrhage from
    • Fractured bone
    • Meningeal vessels
    • Brain itself

• If facial structures are involved in injury, soft tissue trauma and facial bone fractures can occur
  – Consider central nervous system injury
  – Assume cervical fracture when evaluating injuries to head
  – Compression injury to vertebral bodies can result in
    • Compression fracture
    • Hyperextension
    • Hyperflexion injury
Thoracic Injuries

- Compression injury to thorax often involves lungs and heart
  - Associated injuries to external structures
    - Fractured ribs and sternum
    - Can lead to unstable chest wall, open pneumothorax, or both

Thoracic Injuries

- Serious lung injury that can occur from compression forces is called paper bag effect
  - Occurs when increased intrathoracic pressure causes rupture of lungs
  - Example: driver of car is threatened by approaching vehicle
    - Driver notes potential collision, instinctively takes deep breath and holds it
    - Protective inhalation fills lungs (paper bag) with air against closed glottis and creates closed container

Thoracic Injuries

- As thorax strikes steering column, inward motion of chest wall causes increase in lung pressure
  - Increased pressure results in alveolar rupture (as when hand strikes paper bag)
  - Phenomenon is thought to be cause of most pneumothoraces after vehicle trauma
  - Penetration of fractured rib through pleura and laceration of lung also contribute to pneumothorax after blunt trauma to chest
Thoracic Injuries

• During compression injury to thorax, heart can become trapped between sternum and thoracic spine
  – Depending on amount of energy applied, compression of contents of abdomen and increase in pressure in aorta, aortic valve could rupture
  – Compression of patient’s heart between sternum and vertebral column can cause
    • Cardiac dysrhythmias
    • Myocardial contusion
    • Atrial or ventricular rupture

Abdominal Injuries

• Compression injuries to abdominal cavity can have serious effects
  – Solid organ rupture
  – Vascular organ hemorrhage
  – Hollow organ perforation into peritoneal cavity
  – Common injuries
    • Rupture of bladder, especially if full
    • Lacerations to spleen, liver, kidneys
Abdominal Injuries

• Just as paper bag effect produces pneumothorax in thoracic injury, compression of abdominal cavity can cause increases in intra-abdominal pressure
  – Increase in pressure can exceed tensile strength (resistance to lengthwise stretch) of walls of hollow organs or diaphragm
  – Predictable injuries
    • Rupture or herniation of diaphragm
    • Rupture of hollow organs such as gallbladder, urinary bladder, duodenum, colon, stomach, small bowel

Other Motorized Vehicular Collisions

• Injuries from other motorized vehicular collisions
  – Motorcycles
  – All-terrain vehicles (ATVs)
  – Motorized personal transportation devices
  – Snowmobiles
  – Motorboats
  – Water bikes
  – Jet skis
  – Farm machinery

Other Motorized Vehicular Collisions

• Small motorized vehicles are thought to be more dangerous than other motor vehicles
  – Offer little protection to rider
  – Offer minimum protection from transfer of energy associated with collisions
  – Injuries usually are more severe than those from car crashes
  – Predictable injuries depend on type of collision that occurs
Motorcycle Collision

• Common motorcycle collisions result from impact that is head-on or at an angle
  – Result from laying motorcycle down

Head-On Impact

• Center of gravity of motorcycle is above front axle, forward of rider’s seat
  – When motorcycle strikes an object that stops its forward motion, rest of bike and rider continue forward until acted on by an outside force
  – Usually, motorcycle tips forward
  – At that point, rider is propelled over handlebars
  – Secondary impacts with handlebars or other objects stop forward motion of rider

Head-On Impact

• Predictable injuries caused by these secondary impacts
  – Head and neck trauma
  – Compression injuries to chest and abdomen
  – If feet remain on foot rests during impact, mid-shaft of femur absorbs rider’s forward motion
    - Can result in bilateral fractures to femur and lower leg
    - Severe perineal injuries can result if rider’s groin strikes tank or handlebars of motorcycle
Angular Impact

- Motorcycle may strike object at angle
  - When this occurs, rider often is caught between motorcycle and second object
  - Predictable injuries include crush-type injuries to patient’s affected side
    - Examples of such are open fractures to femur, tibia, fibula and fracture and dislocation of malleolus

Laying the Motorcycle Down

- Professional racers and recreational riders often use strategy of laying motorcycle down before striking object
  - Protective maneuver separates rider from motorcycle and object
  - Allows rider to slide away from bike
Laying the Motorcycle Down

- Professional racers and recreational riders often use strategy of laying motorcycle down before striking object
  - Predictable injuries
    - Massive abrasions (road rash)
    - Fractures to affected side as rider slides on ground or pavement
  - These injuries can be severe
  - Usually less serious than those that occur from other types of impacts

All-Terrain Vehicles

- Injuries from crashes involving ATVs are different from those seen in motorcycle collisions
  - ATVs have higher center of gravity than motorcycles
  - Also have large, flat front tire that makes them difficult to steer
  - Specific balance different than that required for riding motorcycles or bicycles is necessary to keep ATV from overturning
All-Terrain Vehicles

- Natural tendency is for rider to put foot down to support ATV when stopping
  - Can lead to rear tire running over rider’s foot, catching leg, and throwing rider forward off vehicle and onto his or her shoulder or crushing rider
  - Predictable injuries from ATV collisions
    - Extremity injury and fracture
    - Clavicular fracture
    - Serious head and neck injuries

Personal Protective Equipment

- Protective equipment for riders of small motor vehicles includes boots, leather clothing, eye protection, and helmets
  - Helmets are structured to absorb energy of impact, thereby reducing injuries to
    - Face
    - Skull
    - Brain
  - Estimated to be 37 percent effective in preventing fatal injuries
  - Nonuse of helmets increases head injuries by more than 300 percent

Pedestrian Injuries

- In 2006, 70,000 persons were injured in auto-pedestrian collisions in United States
  - Of those, 6,100 were fatal
  - All collisions of this nature can cause serious injuries
  - Require high degree of suspicion for multiple-system trauma
Pedestrian Injuries

- Three main mechanisms of injury (multiple impacts) exist in auto–pedestrian collisions
  - First impact occurs when bumper of vehicle strikes body
  - Second occurs as pedestrian strikes hood of vehicle
  - Third occurs when pedestrian strikes ground or another object

Pedestrian Injuries

- Predictable injuries depend on whether pedestrian is adult or child
  - Variations in height of pedestrian in relation to bumper and hood of car affect injury pattern
  - Velocity of vehicle also is major factor
  - Low speeds can result in serious trauma because of mass of vehicle and transfer of energy
  - Another consideration in evaluating an auto–pedestrian collision is possibility patient may have been hit by another vehicle

Adult Pedestrian

- Most adult pedestrians who are threatened by oncoming vehicle try to protect themselves by turning away from vehicle
  - Injuries often result of lateral or posterior impacts
  - During initial impact, adult usually is struck by vehicle bumper in lower legs
    - Often produces lower-extremity fractures
Adult Pedestrian

• Second impact occurs as pedestrian falls toward hood of vehicle
  – Can result in fractures to femur, pelvis, thorax, spine
  – Can produce intra-abdominal or intrathoracic injury
  – Head and spine can be injured if victim strikes hood or windshield

Adult Pedestrian

• Third impact occurs as victim strikes ground or is thrown against another object
  – Can result in serious damage to hip and shoulder of affected side as body makes contact with landing surface
  – Sudden deceleration and compression forces are associated with impact
    • Fractures
    • Internal hemorrhage
    • Head and spinal injury

Child Pedestrian

• Adults try to protect themselves from auto–pedestrian injury
  – Children tend to face oncoming vehicle
  – Injuries often are result of frontal impact
  – Because children are smaller than most adults, initial impact of vehicle occurs higher on body
  – Impact usually occurs above knees or pelvis
  – Predictable injuries from initial impact include fractures to femur and pelvic girdle and internal hemorrhage
Child Pedestrian

• Second impact occurs as front of hood of vehicle continues forward, making contact with victim’s thorax
  – Victim instantly is thrown backward, forcing head and neck to flex forward
  – Depending on position of patient in relation to vehicle, child’s head and neck may contact hood of vehicle
  – Predictable injuries
    • Abdominopelvic and thoracic trauma
    • Facial trauma
    • Head and neck injury

Child Pedestrian

• Third impact occurs as child is thrown downward to ground or another landing surface
  – Because of child’s smaller size and weight, child can fall under vehicle and be dragged for some distance
  – Child also can fall to side of vehicle and be run over by front or rear wheels
  – Predictable injuries consist of those previously described and may include traumatic amputation

Other Causes of Blunt Trauma

• Other causes of blunt trauma
  – Sports injuries
  – Vertical falls
  – Blast injuries
Sports Injuries

• Persons of all ages take part in sports
  – Sports often associated with injuries
    • Contact sports
    • High-velocity sports
    • Racquet sports
    • Water sports
    • Recreational and competitive equestrian sports
  – Sports offer range of health benefits
    • Can produce severe injury

Sports Injuries

• Injuries related to sports caused by
  – Forces of acceleration and deceleration
  – Compression
  – Twisting
  – Hyperextension
  – Hyperflexion

Sports Injuries

• Use general principles of kinematics to predict injuries by determining following
  – What energy forces were transferred to the patient?
  – To what part of the body was energy transferred?
  – What associated injuries should be considered as a result of energy transfer?
  – How sudden was the acceleration or deceleration?
  – Was compression, twisting, hyperextension, or hyperflexion involved in the injury?
Injuries related to sports often occur outside. What other considerations will you have for patient care based on the environment?

Sports Injuries

- If patient used protective equipment, paramedic should evaluate it
  - Will help paramedic determine mechanism of injury
    - Condition and structural stability of helmet can provide clues as to amount of energy transferred to patient during injury
    - Broken skis, broken hockey sticks, structural deformities of bicycles

Blast Injuries

- Blast injury is damage to patient who is exposed to pressure field that is produced by explosion of volatile substances
  - Explosions of this nature mainly have been wartime concern
  - Recent years, number of blast injuries has increased
    - Result from homemade bombs used in social protests and terrorist activities
Blast Injuries

• Other causes
  – Exploding car batteries
  – Industrial use of volatile substances
  – Chemical reactions in clandestine drug laboratories
  – Explosions in mining
  – Transportation incidents or crashes involving hazardous materials

In all incidents related to blast injury, what is your first consideration on the scene?

Blast Injuries

• Blasts release large amounts of energy
  – Energy is in form of pressure and heat
  – If release of energy is confined in casing (e.g., a bomb), pressure ruptures casing and ejects fragments of housing at high velocity
  – Remaining energy is transmitted to surrounding environment
    • Can severely injure bystanders
Blast Injuries

• Blasts release large amounts of energy
  – Blast injury classifications
    • Primary
    • Secondary
    • Tertiary
    • Miscellaneous

Primary Blast Injuries

• Result from sudden changes in environmental pressure
  – Usually occur in gas-containing organs
  – Most severe damage occurs when poorly supported tissue is displaced beyond its elastic limit
  – Organs and tissues most vulnerable to primary blast injury
    • Ears
    • Lungs
      – Blast lung injury (BLI)
    • Central nervous system
    • GI tract
Primary Blast Injuries

• Predictable damage to these areas
  – Hearing loss
  – Pulmonary hemorrhage
  – Cerebral air embolism
  – Abdominal hemorrhage
  – Bowel perforation

Primary Blast Injuries

• Thermal burns also can result from release of energy in form of heat
  – Injuries likely to occur on unprotected areas close to source of explosion
  – In closed spaces, because of blast reflection, victims farther from explosion may be injured as severely as those close to explosion

Secondary Blast Injuries

• Secondary blast injuries usually result when bystanders are struck by flying debris
  – Obvious injuries are lacerations and fractures
  – Flying debris can cause high-velocity missile-type injuries
    • Can result if nails, screws, or casing fragments are part of debris
Tertiary Blast Injuries
• Occur when victims are propelled through space by explosion and strike stationary object
  – Injuries are similar to those from vertical falls
  – Similar to those from ejections from cars or small motor vehicles
  – In most cases, sudden deceleration from impact causes more damage than acceleration through space because deceleration is more sudden
  – Injuries from these forces include damage to
    • Abdominal viscera
    • Central nervous system
    • Musculoskeletal system

Miscellaneous Blast Injuries
• Miscellaneous blast injuries result from
  – Radiation exposure
  – Inhalation of dust and toxic gases
• Predictable injuries include those to eyes, lungs, soft tissues

Vertical Falls
• Falls accounted for 21,200 deaths in 2006 and were third leading cause of accidental death in United States
  – In predicting injuries associated with falls, evaluate 3 things:
    • Distance fallen
    • Body position of patient on impact
    • Type of landing surface struck
  – Injuries associated with vertical falls are result of deceleration and compression
    • More than half of all falls occur in homes
    • 4 of 5 involve persons 65 years or older
Vertical Falls

- Falls from some levels rarely associated with fatal injury
  - Falls from distances more than three times height of individual (15 to 20 feet) more likely to be associated with severe injuries

Which patients may be susceptible to serious injury from a fall that is from a low level?

Vertical Falls

- Adults who have fallen more than 15 feet usually land on their feet
  - Predictable injury is bilateral calcaneus fractures
    - As energy dissipates from initial impact, the head, torso, pelvis push downward
    - Body is forced into flexion
Vertical Falls

• When this occurs, hip dislocations and compression fractures of spinal column in thoracic and lumbar areas are seen
  – About 10 percent of patients with calcaneal fracture have associated spinal fractures
  – If patient leans forward or tries to break fall with outstretched hands, bilateral Colles’ fractures to wrists are likely

Vertical Falls

• If distance fallen is less than 15 feet, most adults land in position in which they fell
  – Adult who falls head first strikes landing surface with head, arms, or both
  – Predictable injuries depend on body part that strikes landing surface and route of transfer of energy through body

Vertical Falls

• Suspect internal injuries if trunk of body is initial impact area
  – Ability of landing surface to absorb energy influences severity of injury
  – Less damage is expected from fall on soft, grassy surface than from fall on asphalt or concrete
Vertical Falls

• Children tend to fall head first, regardless of distance fallen or body position during fall
  – Heads are proportionally larger and heavier
  – Children who experience vertical fall usually are victims of head injury
  – Older adult patients sustain high number of low-distance falls, often resulting in hip fracture

Penetrating Trauma

• Injury that occurs when object pierces skin and enters tissue of body, creating open wound
  – All penetrating objects, regardless of velocity, cause tissue disruption
    • Occurs as result of two types of forces: crushing and stretching
  – To determine which of two mechanisms of injury predominates
    • Character of penetrating object
    • Speed of penetration
    • Type of body tissue it passes through or into

Cavitation

• Opening produced by force that pushes body tissues laterally away from tract of projectile
  – Amount of cavitation produced by projectile related directly to density of tissue it strikes
  – Related directly to ability of body tissue to return to its original shape and position
Cavitation

• Consider person who receives a high-velocity blow to abdomen
  – Experiences abdominal cavitation at moment of impact
  – Because of lower density of abdominal musculature, cavitation is temporary
  – Cavitation is temporary even in presence of severe intra-abdominal injury

Cavitation

• Permanent cavities are produced by penetrating injuries in which force of projectile exceeds tensile strength of tissue
  – Tissues with high water density (e.g., liver, spleen, and muscle) or solid density (e.g., bone) are more prone to permanent cavitation
  – Certain injuries (e.g., stab wound to abdomen) can produce cavitations as tissues are displaced in frontal and lateral directions
Ballistics

• Energy created and dissipated by object into surrounding tissues determines effect of projectile on body
  – Consider principles of kinematics when dealing with injuries from penetrating trauma
  – Kinetic energy = 1/2 mass of object x square of its velocity

Ballistics

• With reference to ballistic trauma, doubling mass doubles energy
  – Doubling velocity quadruples energy
  – Small-caliber bullet traveling at high speed can produce more serious injury than large-caliber bullet traveling at lower speed
    • As long as large-caliber bullet does not strike major vessel or organ

Damage and Energy Levels of Projectiles

• Low-energy projectiles such as knives, needles, and ice picks cause tissue damage by their sharp, cutting edges
  – Amount of tissue crushed in these injuries usually is minimal because amount of force applied in wounding process is small
  – More blunt penetrating object, more force that must be applied to cause penetration
  – More force needed to cause penetration, more tissue crushed
  – Damage of tissue from low-energy injuries usually is limited to pathway of projectile
When evaluating patient with stab wound, attempt to identify weapon used to cause wound
  – Consider possibility of
    • Multiple wounds
    • Embedded weapons
    • Hidden yet extensive internal damage to organs of thorax and abdomen
    • Penetration of multiple body cavities

High degree of suspicion of serious injury is also indicated for stab wounds to areas of back and flank
  – Wounds may be associated with penetrating injuries to hollow organs and injuries to retroperitoneal organs, specifically the kidneys
  – Penetrating injuries of thorax can involve abdomen, just as abdominal injuries can involve thorax
Your patient has a stab wound in the midaxillary line, lateral to the left nipple. What organs may be affected? What else would you like to know about this injury?

Damage and Energy Levels of Projectiles

• Firearms can be labeled as medium- and high-energy weapons
  – Medium-energy weapons include handguns and some rifles
  – Injury tract produced by both medium- and high-energy weapons usually is two to three times diameter of projectile

Implications of Soft Body Armor

• Some EMS agencies have adopted soft body armor policies
  – Armor offers extra protection for paramedics against blunt and penetrating trauma
  – Most agencies follow U.S. Department of Justice guidelines to determine type of body armor protection for types of weapons most commonly found in their community
Implications of Soft Body Armor

• Seven levels of body armor protection
  – Authorities generally recommend type III or higher protection level for EMS personnel
  – These soft vests protect against low- and some medium- and high-velocity weapons

Wounding Forces of Medium- and High-Energy Projectiles

• Firearm cartridge composed of
  – Bullet made of metal
  – Gunpowder to propel bullet
  – Primer to explode and ignite gunpowder
  – Cartridge case that surrounds these components
• When trigger is pulled, metal hammer strikes firing pin, which ignites primer
  – Gunpowder ignites and forces bullet to exit cartridge case

Wounding Forces of Medium- and High-Energy Projectiles

• Mechanism of injury from firearms is related to energy created and dissipated by bullet into surrounding tissues
• When firearm is discharged, several events affect dissipation of energy and wounding forces of missile
  – As missile travels through air, it experiences wind resistance, or drag
    • The greater drag, greater slowing effect on missile
    • Firearm discharged at close range usually produces more severe injury than same firearm discharged at greater distance
**Wounding Forces of Medium- and High-Energy Projectiles**

- When firearm is discharged, several events affect dissipation of energy and wounding forces of missile
  - As missile travels through air, sonic pressure wave spreads out behind missile
    - Because speed of sound in tissue is about four times speed of sound in air, sonic pressure wave jumps ahead and precedes missile through tissue
    - Pressure wave displaces tissue and sometimes stretches it dramatically
  - Localized crush of tissue in path of missile and momentary stretch of surrounding tissue cause tissue disruption

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**Wounding Forces of Medium- and High-Energy Projectiles**

- When projectile strikes body, tissue stretches at point of impact to allow entry of penetrating object (temporary cavitation)
  - Energy of projectile exceeds tensile strength of tissue
    - Tissue crush occurs, forcing surrounding tissues outward from path of projectile (permanent cavitation)

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**Wounding Forces of Medium- and High-Energy Projectiles**

- Differences in wounds caused by projectiles vary with amount and location of crushed and stretched tissue
  - Wounding forces of missile depend on
    - Projectile mass
    - Deformation
    - Fragmentation
    - Type of tissue struck
    - Striking velocity
    - Range
**Projectile Mass**

- Tissue crush is limited by physical size or profile of projectile
  - If missile strikes point first, crushed area is no larger than diameter of bullet
  - If missile is tilted as it strikes body, amount of crushed tissue is no larger than length and longitudinal cross-section of bullet

**Deformation**

- Some firearm missiles deform when striking tissue
  - Points of these projectiles typically flatten on impact
  - Diameter expands, creating larger area of crushed tissue
  - Military use of these bullets in war is forbidden
Fragmentation

• Each piece of missile crushes its own path through tissue, causing extensive tissue damage
  – Fragments produce larger frontal area than single, solid bullet and disperse energy into surrounding tissues rapidly
  – Tissues weaken from multiple fragment tracts and increase subsequent stretch of temporary cavity
  – Higher velocity, more likely bullet is to fragment
    • If bullet fragments, may be no exit wound

Type of Tissue Struck

• Tissue disruption varies greatly with tissue type
  – Elastic tissues such as bowel wall, lung, and muscle tolerate stretch much better than nonelastic organs such as liver

Striking Velocity

• Velocity of missile determines extent of cavitation and tissue damage
  – Low-velocity missiles localize injury to small radius from center of injury tract
  – These missiles have little disruptive effect, pushing tissue aside
  – High-velocity missiles produce more serious injuries because they lose more energy to tissues and produce more cavitation
Striking Velocity

• Bullet yaw, or tumble, in tissue also contributes to cavitation and tissue damage
  – Center of gravity of wedge-shaped bullet is nearer to base than to nose
  – As missile strikes body tissue, slows rapidly
  – Momentum carries base of bullet forward
    • Center of gravity becomes leading part of missile
    • Forward rotation around center of mass causes end-over-end motion
    • Movement produces more energy exchange and more tissue damage

Range

• Distance of weapon from target is key factor in severity of ballistic trauma
  – Air resistance (drag) slows missile significantly
  – Increasing distance of projectile from target decreases velocity at time of impact

• If firearm is discharged at close range (within 3 feet), cavitation can occur from combustion of powder and forceful expansion of gases
  – Gas and powder can enter body cavity and cause internal explosion of tissue
  – Common with shotgun wounds
Range

• Internal explosion of tissue is less common with handguns because they produce small amount of gas and create small entrance wound
  – Expansion of only gas can cause extensive tissue destruction, especially in enclosed area

Shotgun Wounds

• Shotguns are short-range, low-velocity weapons
  – Fire multiple lead pellets
    • Encased in larger shell
    • Each pellet considered missile capable of producing tissue damage
  – Each shell contains pellets, gunpowder, and a plastic or paper wad that separates pellets from gunpowder
    • Wad of unsterile material increases potential for infection in shotgun wounds

Shotgun Wounds

• Energy transferred to body tissue and tissue damage depends on
  – Gauge of gun
  – Size of pellets
  – Powder charge
  – Distance from victim
• At close range, shotgun injury can create extensive tissue damage similar to that from high-velocity missile weapon
Entrance and Exit Wounds

• Presence of entrance and exit wounds depends on
  – Range
  – Barrel length
  – Caliber
  – Powder
  – Weapon

• In general, entrance wound over soft tissue is round or oval and may be surrounded by abrasion rim or collar

• If firearm is discharged at intermediate or close range, powder burns (tattooing) may be present

Entrance and Exit Wounds

• Exit wounds, if present, are generally larger than entrance wounds
  – Because of cavitation wave that occurs as bullet passes through tissues
  – As bullet exits body, skin can explode, resulting in ragged and torn tissue
  – Splitting and tearing often produces starburst or stellate wound
You locate an entrance wound but no exit wound on a patient who was shot. Does this mean that the injury is not serious?

Entrance and Exit Wounds

- If muzzle is in direct contact with skin at time of firearm discharge, expanding gases can enter tissue
  - These gases can produce crepitus
  - Burning gases also can produce thermal injury at entrance site and along injury tract

Special Considerations for Specific Injuries

- Locating ballistic injuries requires thorough physical examination of patient because trauma from high- and medium-velocity missiles is unpredictable
  - Impact of any projectile is critical in determining type and severity of injury
  - Fractions of an inch can make significant difference in amount of trauma patient suffers
  - Differences often are impossible to distinguish in field
Head Injuries

- Gunshot wounds to head typically are devastating because of direct destruction of brain tissue and subsequent swelling
  - Patients with head wounds often sustain severe face and neck injuries
  - Can result in major blood loss, difficulty in maintaining airway control, spinal instability

Head Injuries

- As medium-energy projectile penetrates skull, energy is absorbed within closed space of cranium
  - Force of injury compresses brain tissue against cranial cavity, often fracturing orbital plates and separating dura from bone
  - Depending on qualities of missile, bullet may not have enough force to exit skull after penetration
    - Occurs with .22- and .25-caliber handguns
    - In these injuries, bullet follows curvature of interior of skull
    - As it follows curvature, produces significant damage

Head Injuries

- High-velocity wounds to skull produce massive destruction
  - Pieces of skull and brain typically are destroyed
  - At close range, high-velocity wounds result in part from large quantities of gas produced by combustion of propellant
  - If weapon is held in contact with head, gas follows bullet into cranial cavity, producing explosive effect
Thoracic Injuries

- Gunshot wounds to thorax can result in severe injury to pulmonary and vascular systems
  - If lungs are penetrated by missile, pleura and pulmonary parenchyma are likely to be disrupted, producing pneumothorax

Thoracic Injuries

- On occasion, pulmonary defect allows air that cannot be expelled to continue to flow into thoracic cavity
  - Subsequent increase in pressure eventually can cause collapse of lung and shift in mediastinum to unaffected side (tension pneumothorax)

Thoracic Injuries

- Vascular trauma from penetrating injuries can result in massive internal and external hemorrhage
  - If pulmonary artery or vein, venae cavae, or aorta is injured, patient can bleed to death within minutes
  - Other vascular injuries from penetrating trauma to thorax can result in hemothorax and, if heart is involved, myocardial rupture or pericardial tamponade
Thoracic Injuries

- Penetrating injury can cause thoracic trauma in absence of visible chest wounds
  - Evaluate all victims of abdominal gunshot wounds for thoracic injury
  - Evaluate all victims of thoracic gunshot wounds for abdominal injury

Abdominal Injuries

- Gunshot wounds to abdomen usually require surgery to determine extent of injury
  - Penetrating trauma can affect multiple organ systems
    - Causing damage to air-filled and solid organs
    - Vascular injury
    - Trauma to vertebral column
    - Spinal cord injury
  - Assume serious injury when managing victims of penetrating abdominal trauma
  - Should be rule even if patient appears stable

Extremity Injuries

- At times, gunshot wounds to extremities are life threatening
  - Sometimes such wounds can result in lifelong disability
  - Special considerations with these injuries include vascular injury with bleeding into soft tissues and damage to nerves, muscles, and bones
  - Evaluate any extremity that has sustained penetrating trauma for bone injury, motor and sensory integrity, and presence of adequate blood flow
Extremity Injuries

- Vessels can be injured by being struck by bullet or by temporary cavitation
  - Either mechanism can damage lining of blood vessel, producing hemorrhage or thrombosis
  - Penetrating trauma can damage muscle tissue by stretching it as muscle expands away from path of missile
  - Stretching that exceeds tensile strength of muscle produces hemorrhage

Extremity Injuries

- Bone struck by penetrating object can be deformed and fragmented
  - If occurs, transfer of energy causes pieces of bone to act as secondary missiles, crushing their way through surrounding tissue

Trauma Assessment

- Major components of assessment for trauma patients, in order
  - Standard precautions
  - Scene size-up
  - General impression
  - Mechanism of injury
  - Primary survey
  - Baseline vital signs
  - Patient history and history of event
  - Secondary assessment
  - Reassessment
Using Mechanism of Injury

• Mechanism of injury (MOI) can be used to guide assessment for trauma patients
• Can be categorized as significant or nonsignificant

Using Mechanism of Injury

• Using MOI as guide for potential for severe injury allows paramedic to make decisions about on-scene assessment and care
  – If MOI is significant, patient usually is in serious or critical condition
    • Needs to be rapidly assessed, stabilized if possible, and quickly transported
    • Scene time should be limited to that required for airway, breathing, and circulatory support, spinal immobilization, and control of severe hemorrhage

Using Mechanism of Injury

• By comparison, on-scene assessment and care for patients with nonsignificant MOI can be modified as needed
  – After completing primary survey, may be appropriate to perform thorough secondary assessment while at scene
    • Focused on patient’s chief complaint or on findings in initial assessment
    • Patient is transported for definitive care
Role of Documentation in Trauma

• Documentation, findings at scene, and provision of patient care should be well documented on patient care report
  – Thorough written record of EMS response will help "paint picture," or recreate injury event, for others who will be involved in patient's care
  – Complete report is essential and will be referred to by hospital personnel

Role of Documentation in Trauma

• Documentation should include notations on anatomical drawing for location of wounds
  – Should include description of scene and history of event
  – Other important components of patient care report
    • Mechanism of injury
    • Response time
    • Time on scene
    • Initial findings

Role of Documentation in Trauma

• Documentation should include notations on anatomical drawing for location of wounds
  – Other important components of patient care report
    • Trauma scoring scales
    • Changes in assessment findings
    • Care provided
    • Important negative findings
    • Bystander care prior to EMS arrival
Summary

• Trauma is the leading cause of death among persons 1 to 44 years of age and is the fifth leading cause of death among all Americans
• Trauma care is divided into three phases: preincident, incident, and postincident

Summary

• Components of the trauma system include injury prevention, prehospital care, emergency department care, interfacility transportation (if needed), definitive care, trauma critical care, rehabilitation, data collection, and trauma registry
• Transport decisions for trauma patients should be made based on structured triage guidelines

Summary

• Injuries are caused by a transfer of energy from some external source to the human body
  — Extent of injury is determined by type of energy applied, by how quickly it is applied, and by part of body to which the energy is applied
• Four laws of physics describe energy and forces that produce injury: Newton’s first law of motion; conservation of energy law; Newton’s second law of motion; and formula for kinetic energy
Summary

- Kinematics is the process of predicting injuries based on the mechanism of injury, forces involved, anatomy, and energy
- Blunt trauma is an injury produced by the wounding forces of compression and change of speed, which can disrupt tissues

Summary

- Four restraining systems are available in the United States: lap belts, diagonal shoulder straps, child safety seats, and air bags
  - All significantly reduce injuries
  - If used inappropriately, can produce injuries

Summary

- Organ injuries can result from sudden movement caused by deceleration and compression forces
  - Recognition of these injuries requires a high degree of suspicion
  - Paramedic must use principles of kinematics
Summary

• Small motorized vehicles such as motorcycles, ATVs, snowmobiles, motorboats, water bikes, and farm machinery are considered more dangerous than other motor vehicles
  – Offer little protection to rider
  – Offer minimal protection from transfer of energy associated with collisions

Summary

• All auto–pedestrian collisions can produce serious injuries
  – Require high degree of suspicion for multiple-system trauma
• Sports provide a variety of health benefits
  – Also can produce severe injury
  – Sports injuries are related to acceleration/deceleration, compression, twisting, hyperextension and hyperflexion mechanisms of injury

Summary

• Blast injury is damage to a patient exposed to a pressure field produced by an explosion of volatile substances
  – Blasts release large amounts of energy in the form of pressure and heat
  – Blast injuries are classified as primary, secondary, tertiary, and miscellaneous
Summary

• Falls from greater than three times the height of a person (15 to 20 feet) are associated with an increased incidence of severe injuries
  – In predicting injuries associated with falls, paramedic should evaluate three things: distance fallen, body position of patient on impact, and type of landing surface struck

Summary

• All penetrating objects, regardless of velocity, cause tissue disruption
  – Character of the penetrating object, its speed of penetration, and type of body tissue it passes through or into determine whether crushing or stretching forces will cause injury

Questions?