


Chapter 20
Trauma Systems/Mechanism of Injury



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Objectives

- Describe incidence and scope of traumatic injuries and death
- Identify roles of the trauma system
- Predict injury patterns
- Describe injury patterns in specific blunt trauma
- Describe the role of restraints in injury prevention and injury patterns

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Objectives

- Discuss how organ motion contributes to injury in each body region
- Identify injury patterns associated with motorcycle and all-terrain vehicle collisions
- Describe pedestrian injury patterns
- Identify sports-, blast-, fall-related injuries
- Describe factors influencing tissue damage from penetrating trauma

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Scenario

It takes a while to find the patient in the woody location. He is a 40-year-old who was shot in the abdomen. His skin is pale and wet, and his clothes are saturated with blood. You administer oxygen, remove his clothing, and load and go, starting two large bore IV lines en route. His vital signs are: BP-70 by palpation, P-136/min, R-28/min.

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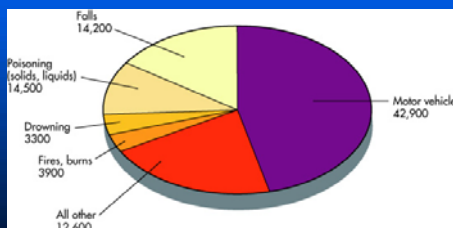
Discussion

- What is your first concern when responding to a shooting?
- Why should you try to find out what type of gun and ammunition were used?
- What clues can you look for to determine what distance he was from the shooter?
- How will you distinguish entrance from exit wounds?

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Trauma

- Epidemiology
- Trends in trauma deaths



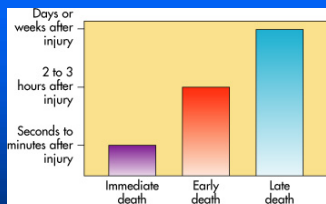
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Phases of Trauma Care

- Three phases
 - Preincident
 - Incident
 - Postincident

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Prevention of Trauma Deaths



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Trauma System Components

- Injury prevention
- Prehospital care
- Emergency department care
- Interfacility transportation (if needed)
- Definitive care
- Trauma critical care
- Rehabilitation
- Data collection/trauma registry

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Trauma System

- Role of the paramedic
- Trauma centers
- Hospital categorization

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Transport Considerations

- Level of care and hospital choice is based on:
 - Patient needs and condition
 - Advice of medical direction
- Ground transport
- Aeromedical transport

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Energy

- Trauma injuries
 - Energy transfer from external source to human body
- Extent of injury determined by:
 - Type of energy applied
 - How quickly it is applied
 - To what part of the body it is applied

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Physics Laws

- Newton's first law of motion
- Conservation of energy law
- Newton's second law of motion

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Kinematics

- Predicting injury patterns
- Consider:
 - Patient's age
 - Protective factors
 - Mechanism of injury
 - Force of energy applied
 - Anatomy
 - Energy

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Blunt Trauma

- Injury produced by compression and change of speed
 - May disrupt tissue
- Direct compression or pressure on a structure
 - Most common type of force in blunt trauma
- Injury depends on:
 - Time of compression
 - Force of compression
 - Area compressed

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Motor Vehicle Collision

- Three impacts as energy is transferred
 - Vehicle strikes object
 - Occupant collides with inside of car
 - Internal organs collide inside body

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Motor Vehicle Collision

- Vehicle crash injuries depend on:
 - Type of collision
 - Position of occupant
 - Use or nonuse of restraint systems
 - Active or passive

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Motor Vehicle Collision

- Type of impact
 - Head on
 - Lateral
 - Rear end
 - Rotational
 - Rollover
- Predictable injury patterns in each type of collision

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Head-On (Frontal) Impact

- Forward motion stops abruptly:
 - First collision
 - Second collision
 - Third collision

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Head-On (Frontal) Impact

- Occupant usually travels in pathways relative to dashboard
 - Down and under
 - Up and over

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Down-and-Under Pathway

- Occupant goes downward into vehicle seat and forward into dashboard or steering column
 - Knees strike dashboard
 - Upper legs absorb impact



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Up-and-Over Pathway

- Body strikes steering wheel
- Momentum of thorax is absorbed by ribs and chest organs



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Lateral Impact

- Vehicle is struck from side
- Injury patterns differ if vehicle:
 - Remains in place
 - Moves away from point of impact

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Rear-End Impact

- Vehicle struck from behind
 - Rapidly accelerates
 - Auto moves forward under occupant
- Forward collisions
 - Damage = Sum of both vehicles' speeds
- Rear-end collisions
 - Damage = Difference between two vehicles' speeds

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Rotational Impact

- Off-center portion of vehicle strikes an immovable object
 - Or one that is moving:
 - More slowly
 - In the opposite direction

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Rollover Accidents

- Occupant tumbles inside auto
- Injured wherever body strikes vehicle
 - Impacts at many different angles
 - May be multiple-system injuries
- Injuries difficult to predict
 - May produce any injury pattern seen in other types of collisions

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Restraints

- Lap belts
- Shoulder straps
- Airbags
- Child safety seats



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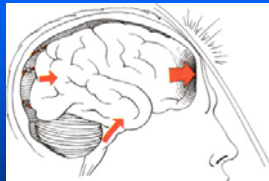
Deceleration Injuries

- After impact organs continue to pull against structures that attach them to the body
 - Organs may separate from attachments
 - Vascular pedicle or mesenteric attachment injury may cause hemorrhage

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Head Injuries

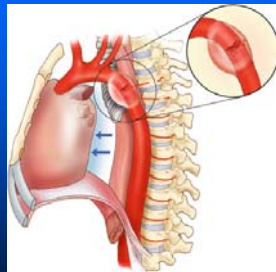
- Head strikes stationary object
- Cranium stops abruptly
- Brain continues moving and is compressed against skull



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Thoracic Injuries

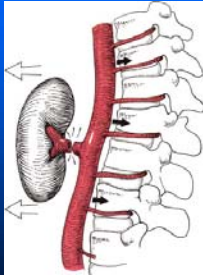
- Aorta often injured by severe deceleration forces
 - Usually sheared at ligamentum arteriosum attachment
- Rupture causes rapid exsanguination



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Abdominal Injuries

- Abdominal organs and retroperitoneal structures (most commonly the kidneys) may be affected by deceleration forces



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Head Injuries

- Compression to head may cause:
 - Open fractures
 - Closed fractures
 - Bone fragment penetration (depressed skull fracture)
- Associated injuries
 - Brain contusion
 - Lacerations of brain tissue

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Head Injuries

- Compression forces to skull can produce hemorrhage from:
 - Fractured bone
 - Meningeal vessels
 - Brain
- If facial structures are involved, soft tissue trauma and facial bone fractures may occur
 - Consider CNS injury and cervical fracture

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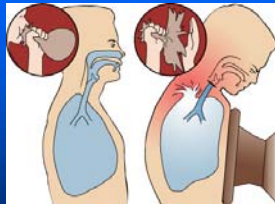
Head Injuries

- Compression injury to vertebral bodies
 - Compression fracture
 - Hyperextension injury
 - Hyperflexion injury

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Thoracic Injuries

- Lungs and heart often involved in compression injury to thorax
- "Paper bag effect" may cause serious lung injury



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Abdominal Injuries

- Compression injuries
 - Solid organ rupture
 - Vascular organ hemorrhage
 - Hollow organ perforation into peritoneal cavity
- Common injuries
 - Lacerations to spleen, liver, and kidney
 - Rupture of a full bladder
- Predictable injuries

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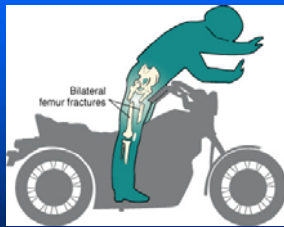
Other Motorized Vehicular Collisions

- All-terrain vehicles (ATVs)
- Snowmobiles
- Motor boats
- Water bikes
- Jet skis
- Farm machinery
- Motorcycles

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Motorcycle Collisions

- Head-on impact
- Rider over handlebars
- Injuries may include:
 - Head and neck
 - Chest and abdomen
 - Femur, lower leg fractures
 - Perineal injuries



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Motorcycle Collisions

- Angular impact
- Rider caught between bike and another object
- Crush injuries to affected side
 - Open fractures of femur, tibia, fibula
 - Fracture dislocation of malleolus

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Motorcycle Collisions

- Laying the motorcycle down
- Massive abrasions
- Fractures of affected side



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Personal Protective Equipment

- Riders of small motor vehicles
 - Boots
 - Leather clothing
 - Eye protection
 - Helmets
 - Absorb energy, reduce head and facial injuries
 - Helmet non-use increases head injuries > 300%

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Pedestrian Injuries

- Impacts in auto-pedestrian collisions
 - Bumper of vehicle strikes body
 - Pedestrian strikes vehicle hood
 - Pedestrian strikes ground or another object

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Pedestrian Injuries

- Predictable injuries depend on:
 - Age of pedestrian
 - Height of pedestrian relative to bumper and hood of car
 - Velocity of vehicle

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Adult Pedestrian

- Most turn away from oncoming auto
 - Lateral or posterior impacts
- Initial impact
- Second impact
- Third impact

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Child Pedestrian

- Tend to face vehicle
 - Often frontal impact
- Initial impact
- Second impact
- Third impact

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Common Sports Injuries

- Contact sports
 - Football
 - Basketball
 - Hockey
 - Wrestling
- Racquet sports
- Swimming and diving

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Common Sports Injuries

- High-velocity activity sports
 - Downhill skiing
 - Water skiing
 - Bicycling
 - Rollerblading
 - Skateboarding

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Causes of Sports-Related Injuries

- Forces of acceleration and deceleration
- Compression
- Twisting
- Hyperextension
- Hyperflexion

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Blast Injuries

- Explosion of volatile substances
 - Primary blast injuries
 - Secondary blast injuries
 - Tertiary blast injuries



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Vertical Falls

- Evaluate:
 - Distance fallen
 - Body position on impact
 - Type of landing surface
- Vertical fall injuries a result of deceleration and compression

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Penetrating Trauma

- Cause tissue disruption
 - Despite velocity
 - Penetrating trauma
- Two forces
 - Crushing
 - Stretching

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Penetrating Trauma

- Factors that determine which of the two mechanisms of injury predominates:
 - Character of penetrating object
 - Speed of penetration
 - Type of tissue it passes through or into

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Cavitation

- Opening produced by a force pushing body tissues laterally away from tract of a projectile

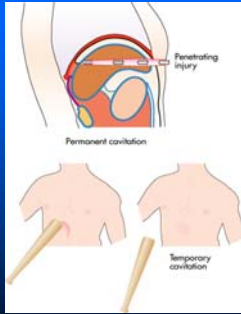
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Cavitation

- Cavitation related to:
 - Tissue density
 - Ability of tissue to return to its original shape and position

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Permanent and Temporary Cavitation



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Ballistics

- Projectile's effect on body determined by energy created and dissipated by object into surrounding tissues
- Damage and energy levels of projectiles
 - Low, medium, and high

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Low-Energy Projectiles

- Knives, needles, and ice picks
- Sharp cutting edges cause tissue damage
- Tissue crushed is usually small because wounding force is small
- Damage usually limited to pathway of projectile

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Stab Wound

Stab wound in which a knife has pierced the liver and pancreas and entered the splenic vein



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Stab Wounds

- Attempt to identify wounding object
- Consider:
 - Multiple wounds
 - Embedded penetrating objects
 - Damage to organs of thorax and abdomen
 - Penetration of multiple body cavities
 - Stab wounds to back and flank—high risk

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Medium-Energy Injuries

- Muzzle velocity of <1500 ft per sec
- Handguns and some rifles
- Injury tract usually 2-3 times diameter of projectile

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High-Energy Injuries

- Muzzle velocity of >1500 ft per sec
- Injury tract usually 2-3 times diameter of projectile

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Medium- and High-Energy Projectiles

- Localized crushing of tissue in missile's path
- Momentary stretch of surrounding tissues
- Wounds vary with amount and location of crushed and stretched tissue

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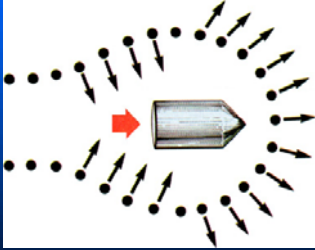
Wounding Forces

- Wounding forces depend on:
 - Projectile mass
 - Deformation
 - Fragmentation
 - Type of tissue struck
 - Striking velocity
 - Range

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Wounding Forces

Bullet passing through tissue



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Shotgun Wounds

- Short range, low velocity
- Tissue damage depends on:
 - Gauge of gun
 - Size of pellets
 - Powder charge
 - Distance from victim

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Entrance and Exit Wounds

- Appearance of entrance and exit wounds affected by:
 - Range
 - Barrel length
 - Caliber
 - Powder
 - Weapon

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Entrance Wound

- Round or oval
- May be abrasion rim or collar
- If discharged at intermediate or close range:
 - Powder burns (tattooing) may be present

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Bullet Wound

Powder marks show this 0.22-caliber bullet wound was inflicted at close range



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Shotgun Wound

Short-range shotgun wound to forearm



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Exit Wounds

- Generally larger than entrance wounds
- Skin may “explode”:
 - Ragged and torn tissue
 - Splitting and tearing often produces a star-burst or stellate wound

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Exit Wound

Exit wound by powerful shotgun at close range



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Head Injuries

- Gunshot wounds to head are typically devastating
 - Often severe facial and neck injuries
 - Significant blood loss
 - Difficulty maintaining airway control
 - Spinal instability

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Thoracic Gunshot Injuries

- Severe injury to pulmonary and vascular systems possible
 - Pneumothorax and tension pneumothorax
 - Internal and external hemorrhage
 - Thoracic trauma possible without visible chest wounds

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Abdominal Gunshot Injuries

- Surgery often needed to determine extent of injury
- May affect multiple organ systems
 - Damage to air-filled and solid organs
 - Vascular injury
 - Spinal column and spinal cord injury

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Extremity Injuries

- Gunshot wounds to extremities:
 - Occasionally life threatening
 - May result in lifelong disability

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Conclusion

The paramedic must understand trauma systems and be able to recognize mechanisms of injury to enhance patient assessment and emergency care.

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Questions?

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