Trauma
Mechanism of Injury
&
Injury Patterns

South Cook County EMS
February, 2016
What Mechanisms were applied here?
Evaluate the MOI

- Who else are you looking for?
- Mechanism of Injury
Trauma Systems & Mechanism of Injury

- Epidemiology
  - Trauma is the leading cause of death for ages 1-44 years
  - 140,000 unexpected deaths per year
  - Automobile related > 40,000
  - Penetrating trauma to exceed blunt in near future
Energy

- **Physical Laws**
  - Newton’s first law of motion
    - A body in motion remains in motion / rest until acted on by outside force
    - A vehicle traveling 50MPH, occupant traveling at 50MPH
    - Vehicle stops, occupant continues until acted on by outside force

- **Conservation of Energy**
  - Energy cannot be created or destroyed
  - Can be changed in form
  - Energy must be absorbed resulting in deformity of substance
Energy Law Summary

- Motion is created by force (energy exchange)
- Force (energy exchange) must stop this motion
- If such energy exchange occurs inside the body, tissue damage is produced
Energy Exchange

- Interaction between two bodies
  - At least one must be in motion
  - Both can be in motion
- Dependant on number of particles involved in the interface of the interaction
  - Density of the interacting bodies
History (of the incident)

- Thorough history will identify 95% of injuries
- Incident site
  - Known “Bad Locations”
- Major factors of tissue injury
  - What forces were applied?
- Amount of energy exchanged
  - Speed of vehicles
- Anatomical structures potentially involved
Don’t get Tunnel Vision

- The leg looks nasty...but is it fatal to him right now?
Keep Assessment Focused

- This injury does not look as bad...but may become fatal
Trauma Systems

- Components of a Trauma System:
  - Injury pattern
  - Prehospital care
  - Emergency department care
  - Interfacility transfer
  - Definitive care
  - Trauma critical care
  - Rehabilitation
  - Data collection – trauma registry
Transport Considerations

- Level of receiving facility
- Mode of transport
  - **Ground transport**
    - If appropriate facility can be reached in reasonable time (Level 1 – 25 min, Level 2 – 30 min)
    - Transport to nearest ED if transport time > 30 min
  - **Air transport**
    - Indications – time frame, # of patients, etc.
    - Contraindications – weather, landing site, etc.
    - Procedure – call time, flight time, etc.
Guideline: Entry into Trauma System
Physiological

- Systolic BP < 90
  - With findings of hypoperfusion
  - Suspected etiology
- Respiratory Distress
  - Rate < 10 or > 29
- Altered Mental Status
- GCS < 10
Anatomical

- Flail Chest
- Two or more long bone fractures
  - Humerus, femur
- Penetrating injury to head, neck, torso or abdomen that is associated with significant energy transfer
- Amputation proximal to the wrist or ankle
- Paralysis of any limb associated with trauma injury
- Combination trauma with >20% total body surface area
Mechanism

- Maternal trauma > 24 weeks
- Death of any occupant in the patient’s vehicle
- Ejection of patient from an enclosed vehicle
- Falls > 20 feet
- Falls > 3x the body length of a child
Co-Morbid Factors

(which may be considered)

- Age < 12 or > 60
- Pregnancy
- Significant preexisting medical problems
- Extremes of environment
  - Hot or cold
- Presence of intoxicants (etoh, etc)
Index of Suspicion

- Any patient who, in the judgement of prehospital personnel, would benefit from transport to a trauma center.
Mechanism of Injury
Types of Trauma

- **Blunt**
  - Tissue not penetrated
  - Cavitation away from site of impact
  - Cavitation in direction of impact

- **Penetrating**
  - Tissue penetrated
  - Cavitation at 90° to bullet pathway
    - Tissue inline penetration is crushed
Blunt Trauma

- Vehicle collisions
  - Frontal
  - Lateral
  - Rear
  - Rotational
  - Roll over
Frontal Impact

- Up and over
  - Body travels up and over steering wheel
- Down and under
  - Body travels down and under steering wheel

*Common injuries seen in frontal impacts may be:*
Up and Over – Rib fractures, hemo/pneumothorax, cardiac contusion, aortic rupture.

Down and Under – Knee dislocation/fx, femur dislocation/fx, pelvic fx.
Frontal Impact
Lateral Impact

- Vehicle struck on side
- Vehicle moves into and impacts body
- Occupant forced away from collision point
- Lateral injury pattern: Examples-
  - Fx ribs, pulmonary contusion, ruptured liver or spleen (depending on side involved), head, neck injuries.
Lateral Impact
Rear Impacts

- Vehicle struck in rear
  - Occupants in direct contact with vehicle will move also
  - The force of the energy exchange depends on the differential energy of the two vehicles
  - Secondary impact as vehicle strikes another object

*Predictable injuries may include: head, neck, back strain or fx due to hyperextension.*
Rear Impact
Rotational Impacts

- Pure rotational, one part of vehicle hits an immovable object while the rest continues in motion
- Remainder of vehicle moves around the fixed position
- The motion of the occupant is a combination of two motions
  - Frontal & Lateral
  - Rear & Lateral
- The injuries are combinations of the two motions
Rotational Impact
(may see same injury pattern as lateral and rotational incidents)
Roll Over

- Vehicle and occupant roll over
- Difficult to predict injury pattern / body impacts
- Can include all types of impacts
- Roll Over vs. “Turn Over”
Roll Over
Consider the Force Involved
Ejection

- If the force is such and the occupant is unrestrained, eject can result
- The major injuries occur inside the vehicle and on the way out
- Think of the first part of the collision rather than the latter portion
Motorcycle Collisions Frontal

- Bike stops
- Occupant continues forward
  - Impacts parts of the bike
  - Ejected over the bike
- Injuries
  - C-spine
  - Torso
  - Compound tib/fib
Motorcycle Collisions
Angular

- Collapse of bike onto vehicle
- Lateral motion of torso into vehicle
- Injuries – “crush” type on affected side
  - Torso
    - Lateral chest
    - Lateral abdomen
    - Aorta
    - Pedicled organs
The Real Collisions
Organ Collisions

- Two types of injury from blunt trauma result from:
  - Compression
  - Change in velocity
    - Acceleration
      - Shear
      - Avulsion
  - Deceleration
    - Shear
    - Avulsion
Organ Collisions

Head

- Organ collisions with different vehicular collisions
  - Head
    - Compression (fx skull, cerebral contusions)
    - Deceleration
      - Opposite end separation
      - Hemorrhage
      - Brain stem stretch
Organ Collisions
Neck

- Neck
  - Compression
    - Vertebral body
      - Compression fx
      - Hyperextension injury
      - Hyperflexion injury
  - Shear
    - Spinal cord
Organ Collisions
Thorax

- Thorax
  - Chest wall
    - Compression (rib fractures, pneumothorax)
    - Shear (fractured thoracic spine)
    *Tx for pneumo – chest decompression*
  - Heart
    - Compression (contusion, rupture)
    - Shear
  - Aorta
    - Compression
    - Shear (very bad....)
Organ Collisions
Lung

- Lung
  - Compression
    - Pneumothorax
    - Rib fracture and penetration
  - Shear
    - “paper bag effect” – deep breath prior to impact, impact causes change in lung pressure, alveoli rupture, air escapes into pleural space
Organ Collisions
Abdomen

- Abdominal cavity
  - Diaphragm
  - Abdominal wall
- Liver
  - Compression (burst type injuries)
  - Shear (ligamentum tears) avulsion
- Spleen
  - Compression (burst)
  - Shear (avulsion of pedicle)
Organ Collisions
Abdomen

- Gastrointestines
  - Compression (rupture)
  - Shear (avulsion of mesenteric vessels)

- Gallbladder
  - Compression (rupture)
  - Shear (avulsion from liver)

*Remember, severe abd injuries usually have orthostatic BP changes, patient may be pale, nauseated and dizzy.*
Organ Collisions
Pelvis

- Compression
  - Impact on the femur
    - Femoral head driven through acetabulum
    - Fracture of the ileum
    - Sacro-illiac joint fracture
    - Fracture of other bones in the pelvis
Restrains

- Systems designed to absorb the energy before the occupant hits something hard and limiting the distance the body travels
  - Lap belts
  - Shoulder restraints
  - Air bags
  - Child safety seats
Restraints

- They could cause injury
- Injury could be missed without proper assessment
# Mentation / LOC Assessment

<table>
<thead>
<tr>
<th>Mentation / LOC Status</th>
<th>Description</th>
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<tbody>
<tr>
<td>A-Alert (Able to answer questions)</td>
<td>Able to answer questions</td>
</tr>
<tr>
<td>V-Verbal (Responds to verbal stimuli)</td>
<td>Responds to verbal stimuli</td>
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<tr>
<td>P-Pain (Responds only to pain stimuli. Protect airway)</td>
<td>Responds only to pain stimuli. Protect airway</td>
</tr>
<tr>
<td>U-Unconscious (Protect airway, consider intubation)</td>
<td>Protect airway, consider intubation</td>
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Other Injuries
Falls

- Factors
  - Height
  - Surface of impact
  - Objects struck during decent

- Feet first
  - Impact onto calcaneous
  - Continued motion of the torso
    - Ankles, knees, femur, pelvis, spine, torso
Falls

- Head first
  - Compression
    - Skull fracture
    - Brain
    - Spine
  - Deceleration
    - Aorta
    - Kidney
    - Other
Deceleration

- Dislocated fracture of spine from feet hitting ground first
- What other orthopedic injuries would be expected?
Penetrating Injuries

- Cavitation
  - Permanent
    - Visible when examine
    - Crushed tissue
  - Temporary
    - Compression wave of tissue particles
    - Away from the pathway of the bullet
    - Last only a few microseconds
    - Tissue damage produced by stretch
Density

- Lung (Hollow) Air
- Liver (Water)
- Bone (Solid)
Penetrating Injuries

Anatomy

- Organs injured
- Pathway of missile
  - Entrance wound
    - Hole is crushed forward
    - Round or oval shaped
    - Rim, abrasion, burn
  - Exit wound
    - Pushed outward
    - Stellate or slit
Gunshot to Head

- External affects
- CT of same wound