Trauma

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Background

- UTMC-K Level 1 Trauma Center
  - Regional Teaching Hospital
  - Surgery Residency and Surgical Critical Care Fellowship
  - 250 mile Radius Level 1 Trauma Center Service Area Covering 4 States
  - 3710 Trauma Admissions 2006
  - 32 Bed Dedicated Surgical Critical Care Unit
  - 30% Trauma ICU Admission Rate
Background

- Number one cause of death age 1-44
- Fourth leading cause of death overall
- One half of related to MVCs or firearms
- Three times as many will suffer permanent disability
- $400 billion annual cost
Background

- **Time of death from trauma**
  - **Immediate**
    - Seconds to minutes
    - Injury to CNS, heart, or major blood vessels
  - **Early**
    - Minutes to hours
    - Major hemorrhage
    - Amenable to intervention (ATLS)
  - **Late**
    - Days to weeks
    - Sepsis, organ dysfunction (MODS, MSOF)
Advanced Trauma Life Support

- Developed by the ACS
- Creates changes during the *golden hour*
- Four phases
  - Primary survey
  - Resuscitation
  - Secondary survey
  - Definitive care
Diagnosis and treatment of immediately life-threatening injuries

ABCDE algorithm
  - Airway
  - Breathing
  - Circulation
  - Disability
  - Exposure
Primary Survey--Airway

- Most important aspect of care
- Everyone gets oxygen
- Evaluate for patency, respiratory effort, evidence of hypoxia
- Airway maneuvers
  - Maintain c-spine immobilization
  - Jaw thrust/chin lift
  - Remove foreign bodies, suction
  - Insert oral or nasal airway
  - Airway intubation
  - Surgical airway (eg cricothyroidotomy, tracheostomy)
Primary Survey--*Breathing*

- Assess along with *airway*
- Determine whether respirations are adequate
- Determine whether both lungs are working equally
  - Auscultation
  - Expansion
  - Palpation
  - Percussion
Primary Survey--*Circulation*

- Ensure adequate cardiac function and blood volume
  - Auscultation
  - Palpate peripheral pulses
  - Blood pressure measurement
  - Capillary refill
- Control external hemorrhage
- Assess tissue perfusion
- Give IV fluids
# Primary Survey--Disability

- Assess neurologic disability
- Level of consciousness
- Response to stimuli
- AVPU scale
  - Alert
  - Responsive to vocal stimuli
  - Responsive to painful stimuli
  - Unresponsive
- Glasgow Coma Scale (GCS)

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<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<th>6</th>
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<tbody>
<tr>
<td>Eyes</td>
<td>Does not open eyes</td>
<td>Opens eyes in response to painful stimuli</td>
<td>Opens eyes in response to voice</td>
<td>Opens eyes spontaneously</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>Verbal</td>
<td>Makes no sounds</td>
<td>Incomprehensible sounds</td>
<td>Utters inappropriate words</td>
<td>Confused, disoriented</td>
<td>Oriented, converses normally</td>
<td>N/A</td>
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<tr>
<td>Motor</td>
<td>Makes no movements</td>
<td>Extension to painful stimuli</td>
<td>Abnormal flexion to painful stimuli</td>
<td>Withdrawal to painful stimuli</td>
<td>Localizes painful stimuli</td>
<td>Obeys Commands</td>
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**Glasgow Coma Scale**

- 1: Deep coma
- 2: Semi-coma
- 3: Moderate coma
- 4: Severe coma
- 5: Critical coma
- 6: Normal
Primary Survey -- Exposure

- Remove all clothes & blankets
- Thorough physical exam
- Re-cover with warm blankets
- Prevent hypothermia
Resuscitation

- Initial resuscitation begins when patient hits the door
- Resuscitation is guided with findings from Primary Survey and continuously reassessed until the patient is stable
- Obtain IV access and start IVF
  - Peripheral IVs
  - Central lines
  - Intraosseous lines
  - Use Lactated Ringers solution
  - Initial fluid bolus of 1000 cc in adults, 10-20 cc/kg in children
- If unresponsive to 2000 cc IVF begin blood transfusion
Secondary Survey

- Obtain medical history
  - AMPLE history
    - Allergies
    - Medications
    - Past illnesses
    - Last meal
    - Events
- Place urinary and gastric tubes
- Draw lab studies
- Obtain portable x-rays, ultrasound
- Obtain CT scans, other studies
Definitive Care

- Follows the secondary survey
- Includes procedures, operations, transfer of care, creating a care plan, etc
- Includes patient re-assessment to ensure no changes in status, no missed injuries
Hemorrhagic Shock

- Shock—inadequate organ perfusion
- Hypovolemia secondary to hemorrhage
  - Stop bleeding
  - Restore intravascular volume
- Pathophysiology
  - Compensatory vasoconstriction to preserve oxygen delivery to brain and heart
  - Inadequately perfused cells turn to anaerobic metabolism
  - Lactic acid is formed as a byproduct
  - Cell membrane dysfunction occurs leading to overall dysfunction and eventually death
Classes of Shock

- 70 kg adult has ~5000 cc blood volume
- Class I hemorrhage
  - Blood loss <15% (750 cc)
  - Vital signs normal, may have anxiety
  - Treat with crystalloid
- Class II hemorrhage
  - 15-30% blood loss (750-1500 cc)
  - Tachycardia, pulse pressure decreased, tachypnea, decreased urine output, anxiety/fear/hostility, delayed capillary refill
  - Treat with crystalloid
Classes of Shock

- **Class III hemorrhage**
  - 30-40% blood loss (1500-2000 cc)
  - Tachycardia (>120 bpm), pulse pressure decreased, tachypnea, decreased urine output, anxiety/fear/hostility, delayed capillary refill
  - Treat with IVF & typically blood products

- **Class IV hemorrhage**
  - >40% blood loss (2000 cc)
  - Immediately life threatening
  - Marked derangements in VS and worsening of other symptoms
  - Treat with IVF & blood products
Non-Hemorrhagic Shock

- Much less common in trauma

- Types
  - Cardiogenic
  - Neurogenic
  - Hypoadrenal
Non-Hemorrhagic Shock

- Cardiogenic
  - Myocardial infarction
  - Myocardial contusion (blunt cardiac injury)
  - Cardiac tamponade
    - Reduces venous return to the heart due to direct compression
  - Treat the underlying disorder to relieve shock
Non-Hemorrhagic Shock

• Neurogenic
  - Due to spinal cord injury
  - Sympathetic pathways are disrupted
  - Hypotension with bradycardia
  - Treat with IVF and pressor agents
Non-Hemorrhagic Shock

- Hypoadrenal
  - Typically occurs in people taking steroids
  - Suspect if shock that does not respond to fluids or pressor agents
  - Confirm diagnosis by checking cortisol levels
  - Treat with IV steroid replacement
Abdominal Trauma

- Unrecognized intraabdominal hemorrhage is a leading cause of preventable death
- 20% of pts will have normal abdominal exam
Abdominal Trauma

- **Anatomy**
  - From the diaphragm to the pelvic floor
    - Nipple line to perineum
  - Includes organs in the retroperitoneum

- **Physical exam**
  - Inspect, auscultate, percuss, palpate
  - Involuntary guarding or rebound indicate peritoneal inflammation
  - Check pelvis stability
  - Examine perineum and perform rectal/vaginal exam
Abdominal Trauma
Abdominal Trauma

Diagnostic studies

- Focused Assessment with Sonography for Trauma (FAST)
  - Detects the presence of abnormal fluid in 4 places
    - RUQ between kidney and liver (Morrison’s Pouch)
    - LUQ between kidney and spleen (splenorenal recess)
    - Pelvis around bladder
    - Pericardium

- Pros
  - Rapid, cheap, effective, can be repeated, easily learned, non-invasive

- Cons
  - Limited in obese, bowel gas, subcutaneous emphysema
  - Non-specific
Abdominal Trauma

- **Diagnostic studies**
  - **Diagnostic peritoneal lavage (DPL)**
    - 3-5 cm vertical midline incision made in lower abdomen
    - Aspirated for gross blood
    - Lavaged with fluid and retrieved
    - Sample sent for microscopic analysis
  - **Pros**
    - 98% sensitive for intraperitoneal hemorrhage
  - **Cons**
    - Invasive, perhaps overlysensitive, does not evaluate retroperitoneum, risk of injury, infection
Abdominal Trauma

- **Diagnostic studies**
  - **Computed tomography (CT)**
    - **Pros**
      - Excellent evaluation of most abdominal structures
      - Diagnostic standard for stable patients
    - **Cons**
      - Expensive
      - Poor at evaluating hollow viscus organs
      - Not suitable for unstable patients
Spleen

- Most commonly injured organ in blunt trauma
- Injury severity graded on 1-5 scale
- Low grade injuries often managed non-operatively
- High grade injuries treated with angiographic embolization or surgery
- Must provide vaccines for encapsulated bacteria after splenectomy
Blunt Abdominal Trauma
Blunt Abdominal Trauma
Blunt Abdominal Trauma
Blunt Abdominal Trauma

Liver

- Low grade injuries almost never require operative management
- Injuries graded on 1-5 scale
- High grade injuries treated with angiographic embolization
- Operation reserved for severe injuries
  - Goals are to stop bleeding and prevent bile leak
Blunt Abdominal Trauma
Blunt Abdominal Trauma

- Hollow viscus
  - Small bowel and duodenum most frequently injured
  - Difficult to diagnose
    - Seat belt sign or abdominal bruising
    - Free intraperitoneal fluid on diagnostic studies
Gunshot wounds

- Almost always result in intraabdominal injury
- Laparotomy almost always indicated
- If stable may undergo pre-op imaging studies
Penetrating Abdominal Trauma

- Knife stab wounds
  - If superficial and/or stable may undergo local exploration or imaging studies
  - Unstable patients or those with peritonitis go directly to surgery
Thoracic Trauma

Immediately lethal injuries

- Airway obstruction
- Tension pneumothorax
  - Continuous build-up of air in the pleural space with no means of escape
  - Lung is collapsed, mediastinum displaced, venous return impeded, leading to rapid hypotension, hypoxia, and death
  - Signs/symptoms—resp distress, tachycardia, hypotension, JVD, tracheal deviation, absent breath sounds, tympany
- Clinical diagnosis
- Treat with decompression
Thoracic Trauma
Thoracic Trauma

Immediately lethal injuries

- Hemothorax
  - Blood in the pleural space
  - Massive if >1500 cc immediately or >200 cc/hr x 3 hrs
  - Signs/symptoms similar to Ptx
  - CXR with white out
  - Treat with chest tube, proceed to OR if massive
Thoracic Trauma
Thoracic Trauma

- Immediately lethal injuries
  - Cardiac tamponade
    - Caused by accumulation of blood within the pericardial sac resulting in compression of the heart
    - Ventricular filling decreased giving decreased stroke volume and cardiac output
    - Signs/symptoms—muffled heart sounds, JVD, hypotension
    - Treat with IVF, pericardiocentesis, pericardotomy
Thoracic Trauma

- Immediately lethal injuries
  - Blunt aortic injury
    - Due to abrupt deceleration and tethering of the aorta
    - Common cause of death on scene
    - Signs/symptoms—mechanism of injury, CXR, angiography, CT angiography, echocardiogram
    - Treat with control of blood pressure or surgery
Thoracic Trauma
Thoracic Trauma
Thoracic Trauma

- Potentially lethal injuries
  - Pulmonary contusion
    - Injury to the lung parenchyma
    - Interstitial hemorrhage, edema, alveolar collapse, V/Q mismatch leading to hypoxemia
    - Due to blunt force
    - Associated with rib fractures, sternal fractures, and flail chest
    - Diagnose with CXR or CT
    - Treat with supplemental oxygen, pain control, pulmonary toilet
Thoracic Trauma

Non-lethal injuries

- Pneumothorax & hemothorax
  - Due to lung laceration, rib fractures, or chest wounds that extend to pleural space
  - Signs/symptoms—shortness of breath, pain with inspiration, splinting, hypoxia
  - Diagnosis confirmed with CXR
  - Treat with chest tube if large or symptomatic
Thoracic Trauma
Neurologic Trauma

- Head injury
  - Most common cause of trauma-related mortality
  - Causes >50% of trauma deaths
  - Leading cause of disability
  - Due to blunt or penetrating injury
Neurologic Trauma

- Head injury
  - Primary injury
    - The insult caused by the trauma
    - May be laceration, contusion, shear injury
    - Difficult to treat
  - Secondary injury
    - Injury to the brain caused by post-injury clinical factors
    - Preventable and treatable
    - Must avoid hypoxia, hypotension, fever
Neurologic Trauma

- Head injury
  - Variable material within a fixed space
  - Increase in intra-cranial pressure may lead to herniation and death
Neurologic Trauma

Head injury evaluation
- AMPLEx—mental status at the scene
- AVPU—current level of consciousness
- GCS—quantitative assessment of level of consciousness
  - Widely accepted
  - Reproducible
  - Useful in describing the severity of injury
  - Good prognostic indicator
- Physical exam—pupils and extremity strength
- Imaging—CT scan of the brain
Neurologic Trauma

**Head injury management**

- Starts with primary survey and resuscitation
- Minor injuries may require observation only
- Major injuries may require ICU care, intubation, and intracranial pressure monitoring
  - Ventricular catheter
  - ICP bolt
Neurologic Trauma
Neurologic Trauma

- Head injury management
  - Major injuries
    - Support cerebral perfusion
    - Prevent elevated intracranial pressure
    - Head of bed to 30 degrees, moderate hyperventilation, prudent fluid use
    - Must avoid hypoxia, hypotension, fever
    - Mannitol
      - Osmotic diuretic
      - Reduces brain swelling and lowers ICP
    - Treat seizures immediately
    - Initiate early enteral nutrition
Neurologic Trauma

- **Spinal cord injuries**
  - Must be considered in polytrauma patients
  - Initial management is with spine immobilization
  - Evaluate with physical exam, presence of certain reflexes, x-rays and CT scans
  - High injuries (above T5) can give neurogenic shock
  - Injuries necessitate neurosurgical consultation
  - Rehabilitation is an important part of long term management
Neurologic Trauma
Musculoskeletal Trauma

- Life-threatening extremity injuries include severe open fractures, proximal amputations, major crush injuries, and multiple fractures
- Knowledge of anatomy to predict associated injuries critical
- Can be associated with major blood loss
- Evaluation
  - Complete physical exam
  - Note wounds, deformities, swelling, bruising, misalignment, pain with palpation
  - Check strength, sensation, range of motion
Musculoskeletal Trauma

- **Initial management**
  - Control bleeding with direct pressure or tourniquets
  - Irrigate and debride wounds
  - Reduce dislocations and splint fractures ASAP
  - Obtain radiographs
  - Provide tetanus
  - Possibly provide antibiotics
Musculoskeletal Trauma
Musculoskeletal Trauma
Vascular injuries

- Evaluation
  - **Hard signs**
    - Pulselessness
    - Cold, blue extremity
    - Expanding hematoma
    - Pulsatile bleeding
    - Palpable thrill, audible bruit
  - Doppler exam
  - Ankle-brachial index
  - Angiography & CT angiography
- Treat with vascular surgical repair
Musculoskeletal Trauma

**Compartment syndrome**
- Increase in fascial compartment pressure that leads to high interstitial tissue pressure
- Often associated with vascular injury, crush injuries, and certain fractures
- Most common in calf and forearm
- May develop rapidly
Musculoskeletal Trauma

Compartment syndrome

- Look for 5 P’s
  - Parasthesias
  - Pain
  - Pallor
  - Poikilothermia
  - Pulselessness
- Diagnosis is clinical
- Support with compartmental pressure measurements
Musculoskeletal Trauma

- **Compartment syndrome**
  - Treat by fasciotomy
  - Anticipate renal failure
    - Due to muscle breakdown
    - Treat with IVF, mannitol, alkalinization
Questions?