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

Primary Survey

- 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
- Glascow Coma Scale (GCS)

	1	2	3	4	5	6
Eyes	Does not open eyes	Opens eyes in response to painful stimuli	Opens eyes in response to voice	Opens eyes spontaneously	N/A	N/A
Verbal	Makes no sounds	Incomprehensible sounds	Utters inappropriate words	Confused, disoriented	Oriented, converses normally	N/A
Motor	Makes no movements	Extension to painful stimuli	Abnormal flexion to painful stimuli	Withdrawal to painful stimuli	Localizes painful stimuli	Obeys Commands

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

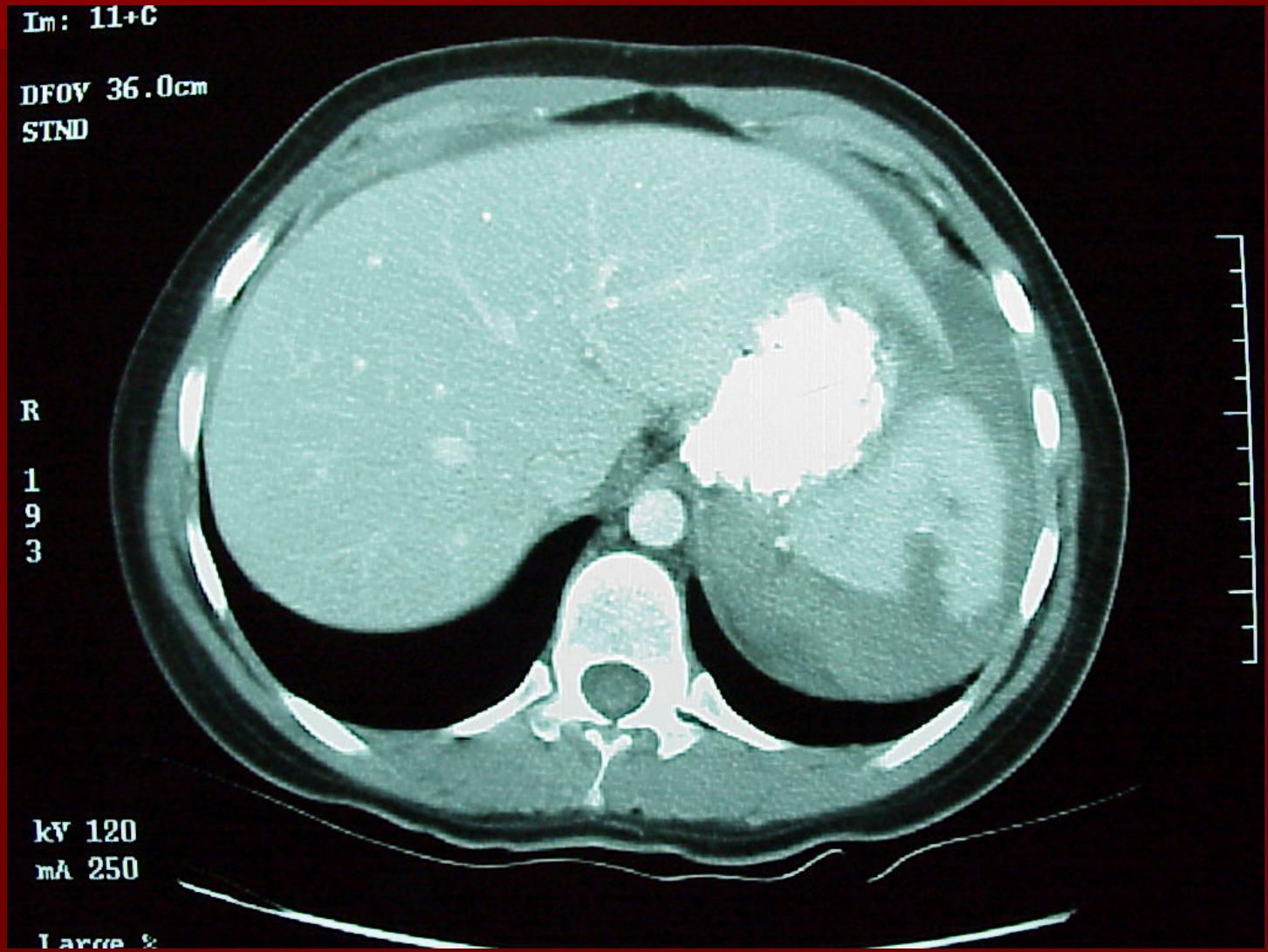
Abdominal Trauma

- 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

Blunt Abdominal Trauma

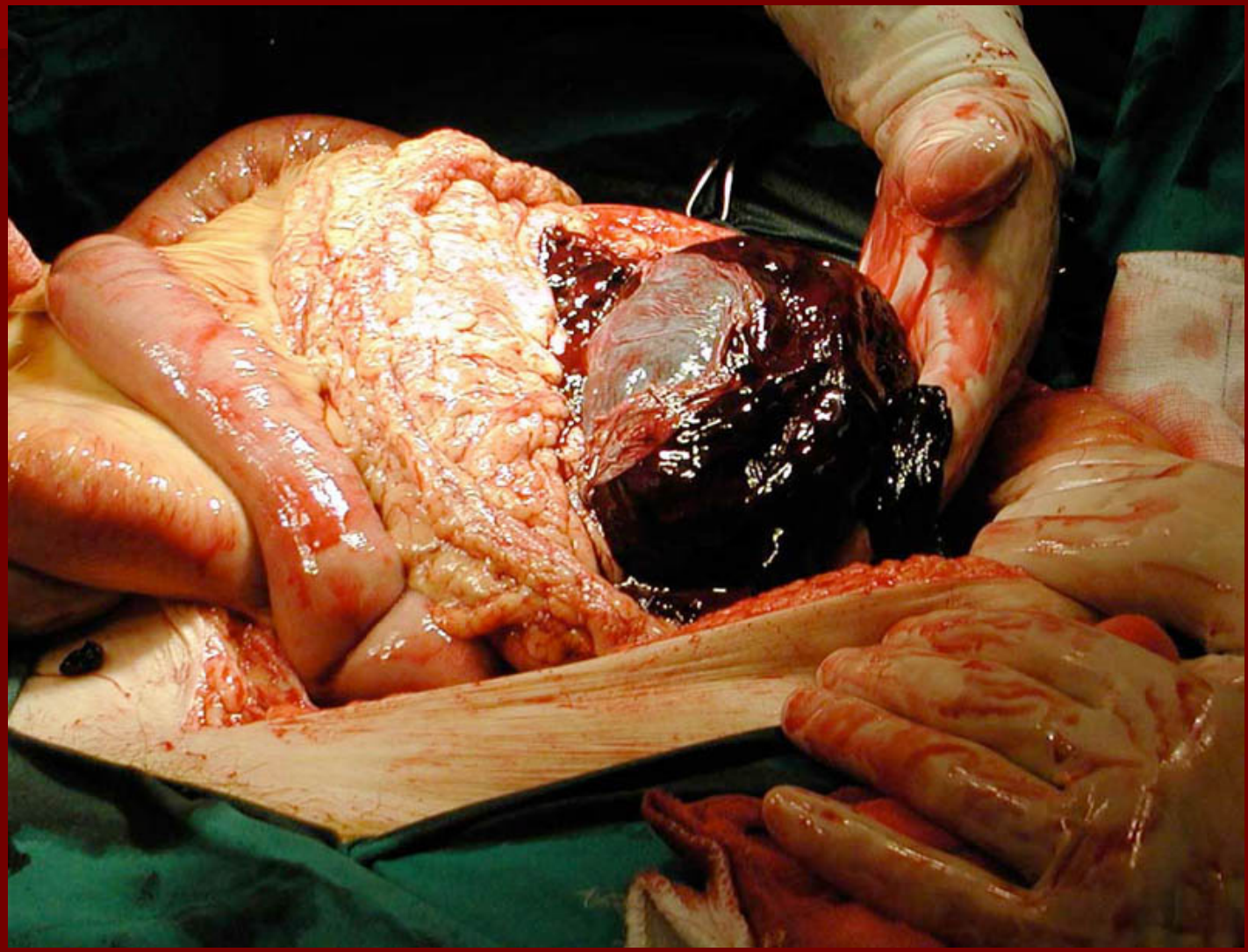
- Spleen
  - Most commonly injured organ in blunt trauma
  - Injury severity graded on 1-5 scale
  - Low grade injuries often managed non-operatively
  - High grade injuries treated with angiographic embolization or surgery
  - Must provide vaccines for encapsulated bacteria after splenectomy

Blunt Abdominal Trauma



Blunt Abdominal Trauma

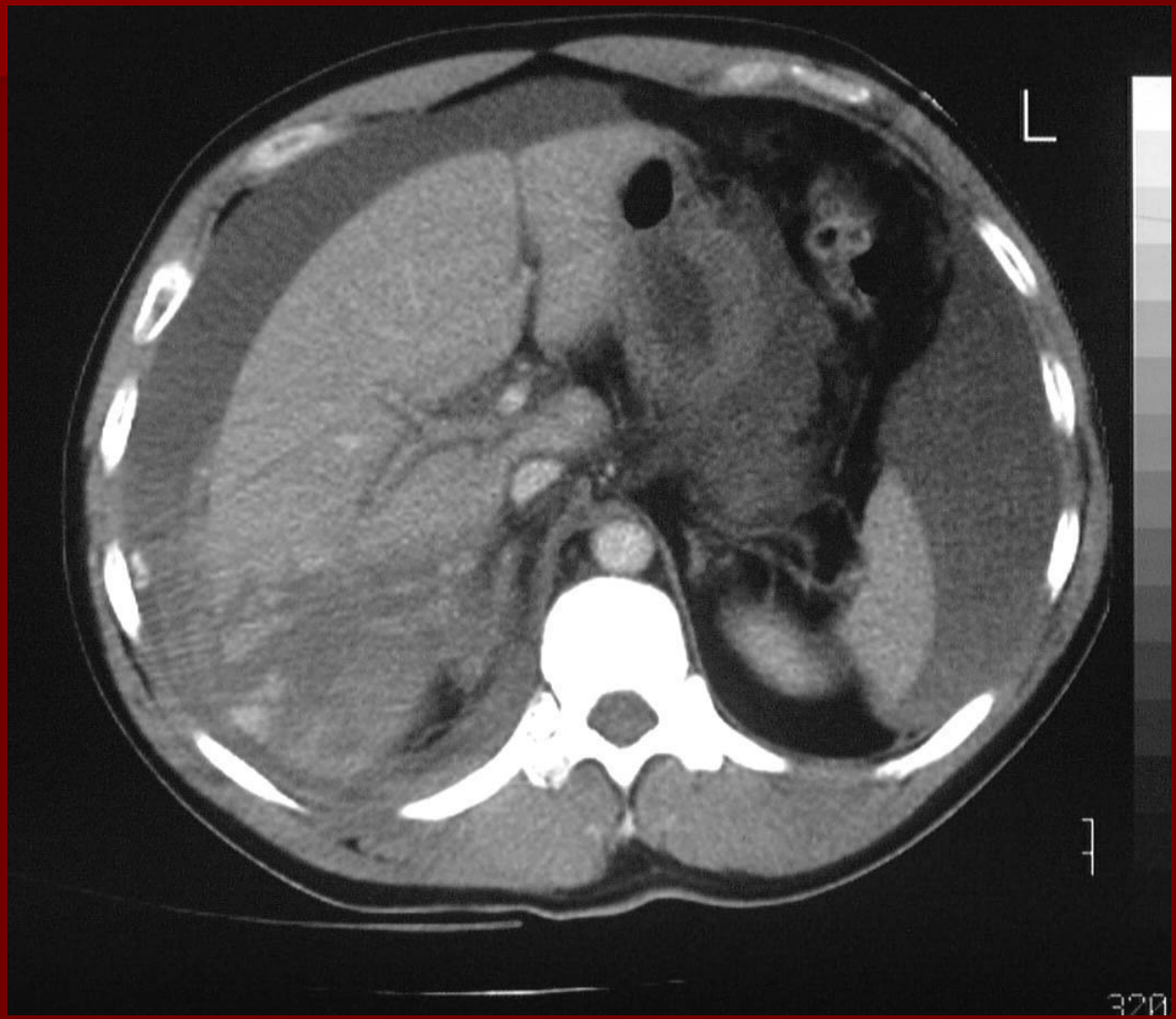
Blunt Abdominal Trauma



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

Penetrating Abdominal Trauma

- Gunshot wounds
  - Almost always result in intraabdominal injury
  - Laparotomy almost always indicated
  - If stable may undergo pre-op imaging studies

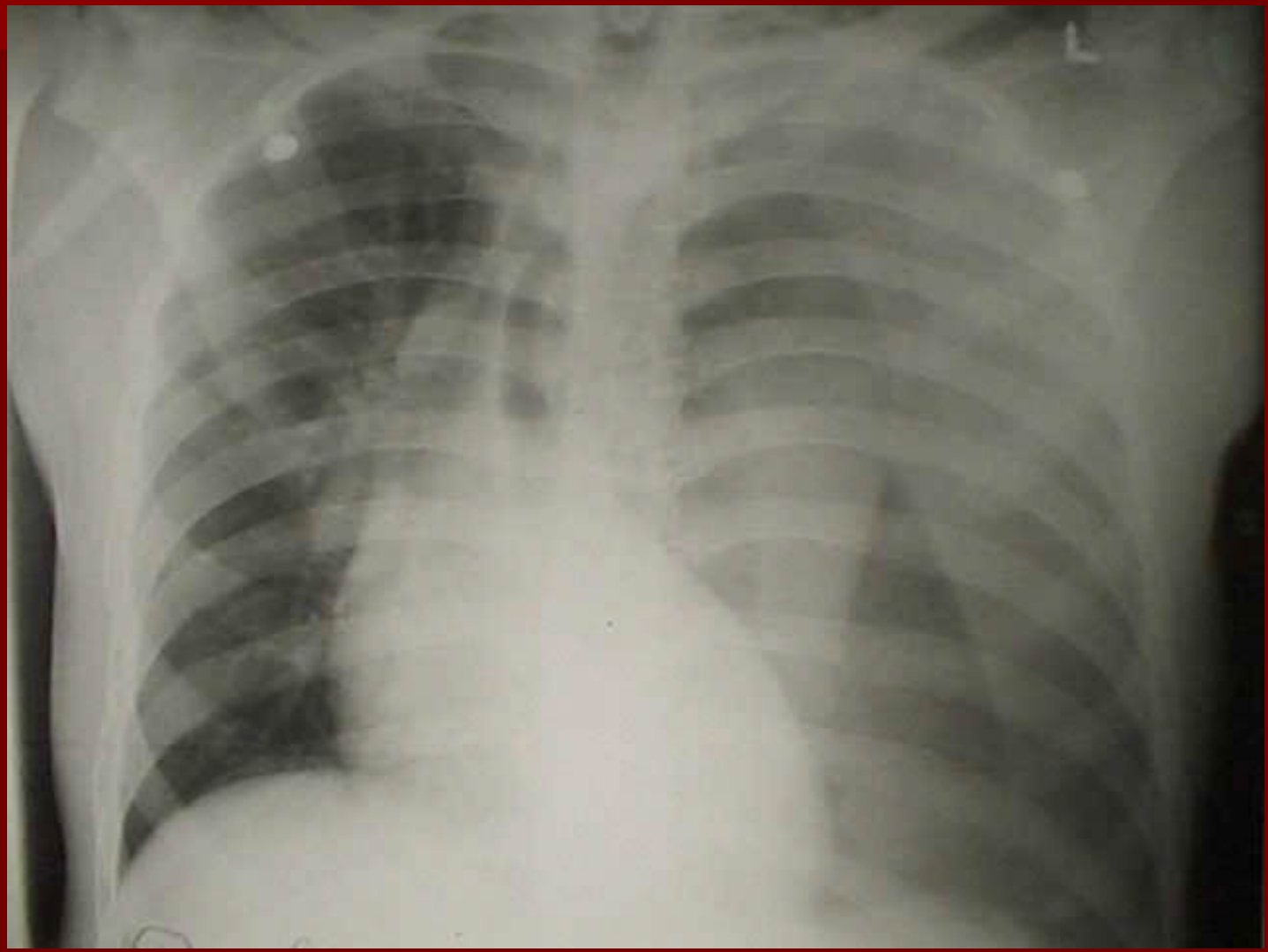
Penetrating Abdominal Trauma

- 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

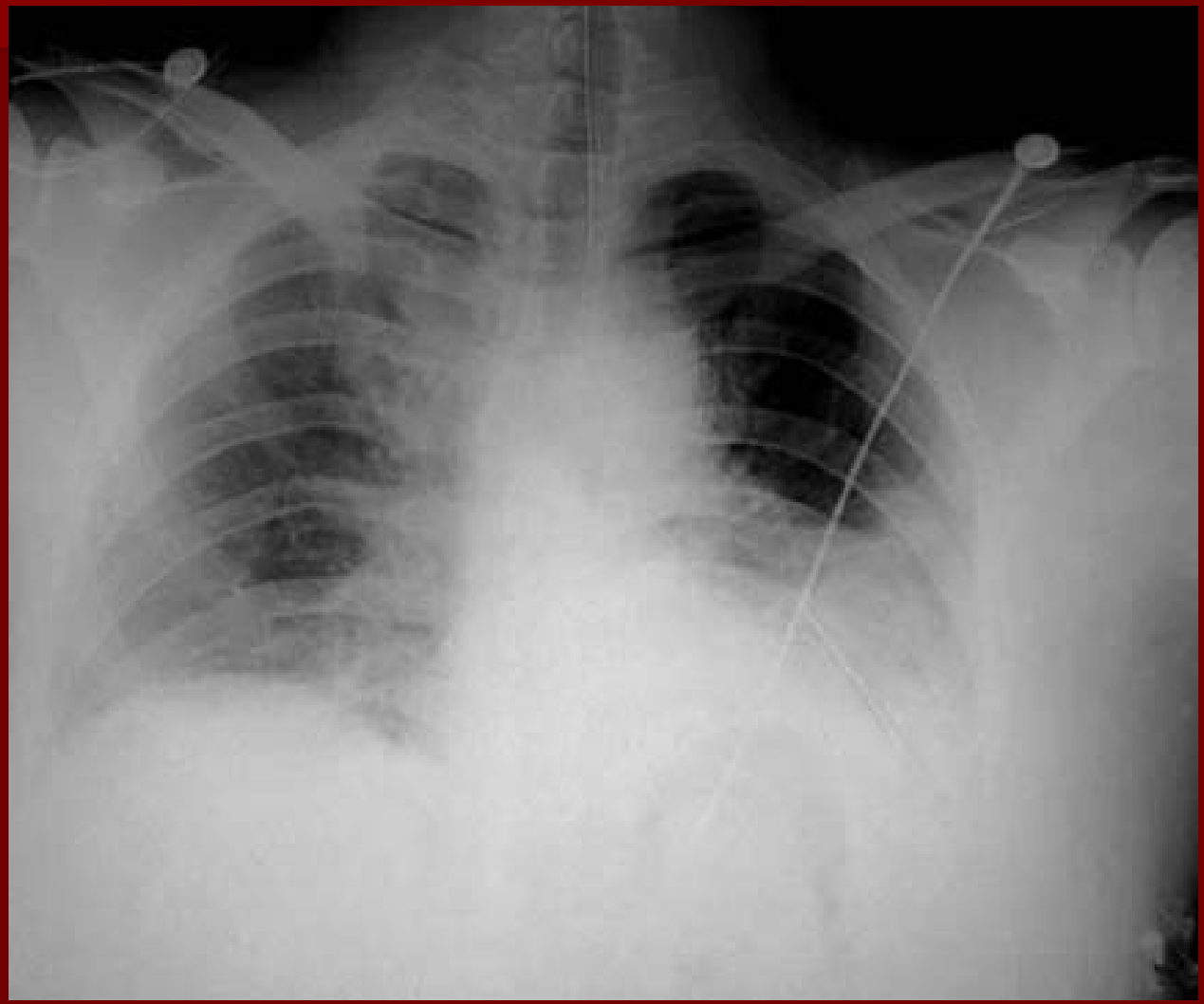
Thoracic Trauma



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

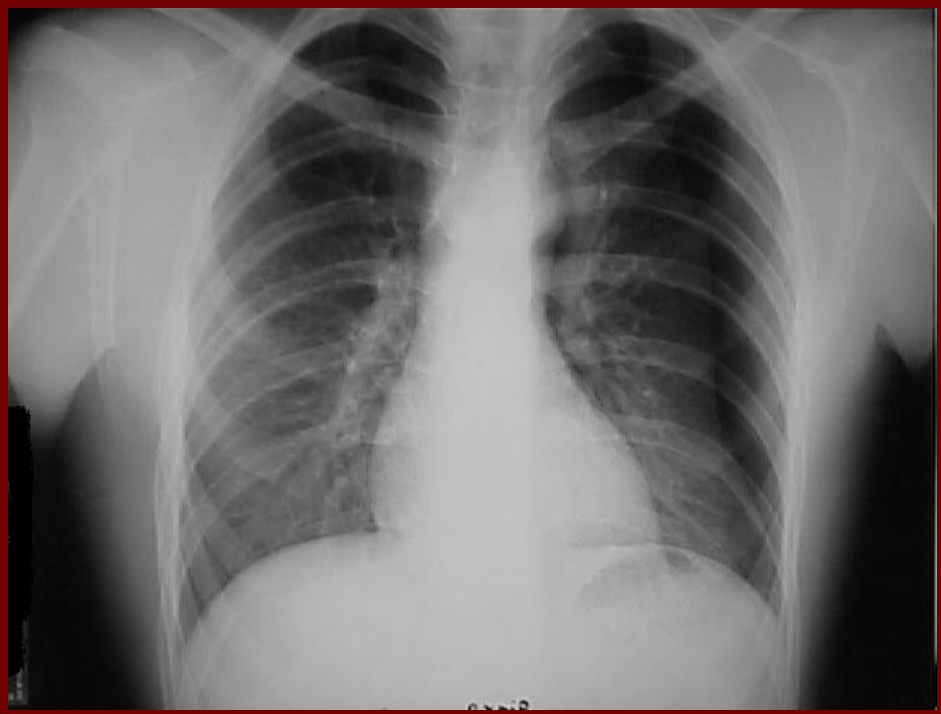
Thoracic Trauma

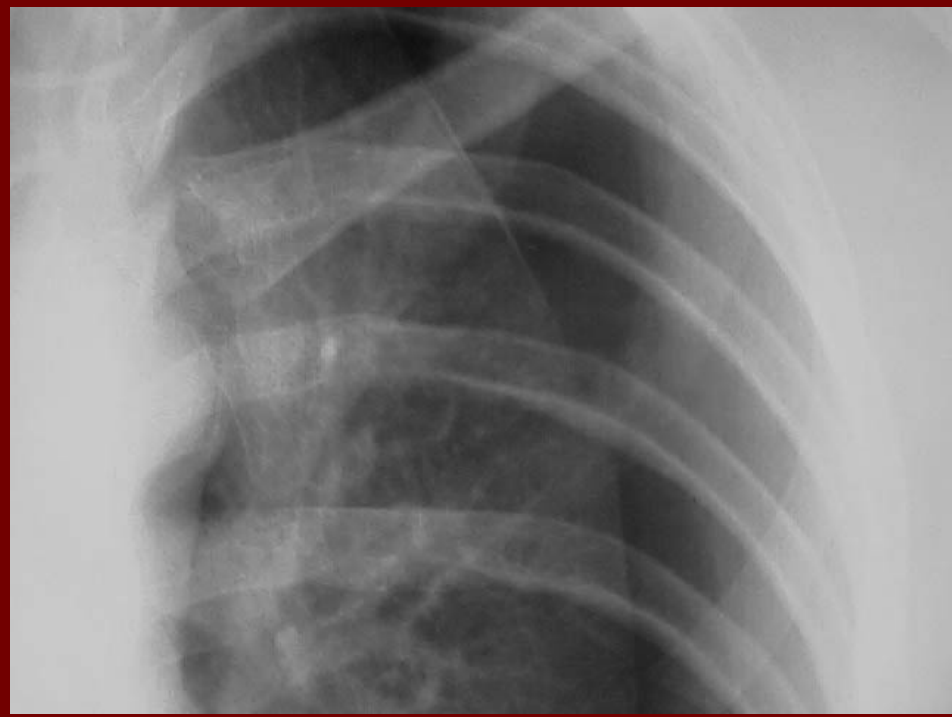
- Potentially lethal injuries
  - Pulmonary contusion
    - Injury to the lung parenchyma
    - Interstitial hemorrhage, edema, alveolar collapse, V/Q mismatch leading to hypoxemia
    - Due to blunt force
    - Associated with rib fractures, sternal fractures, and flail chest
    - Diagnose with CXR 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

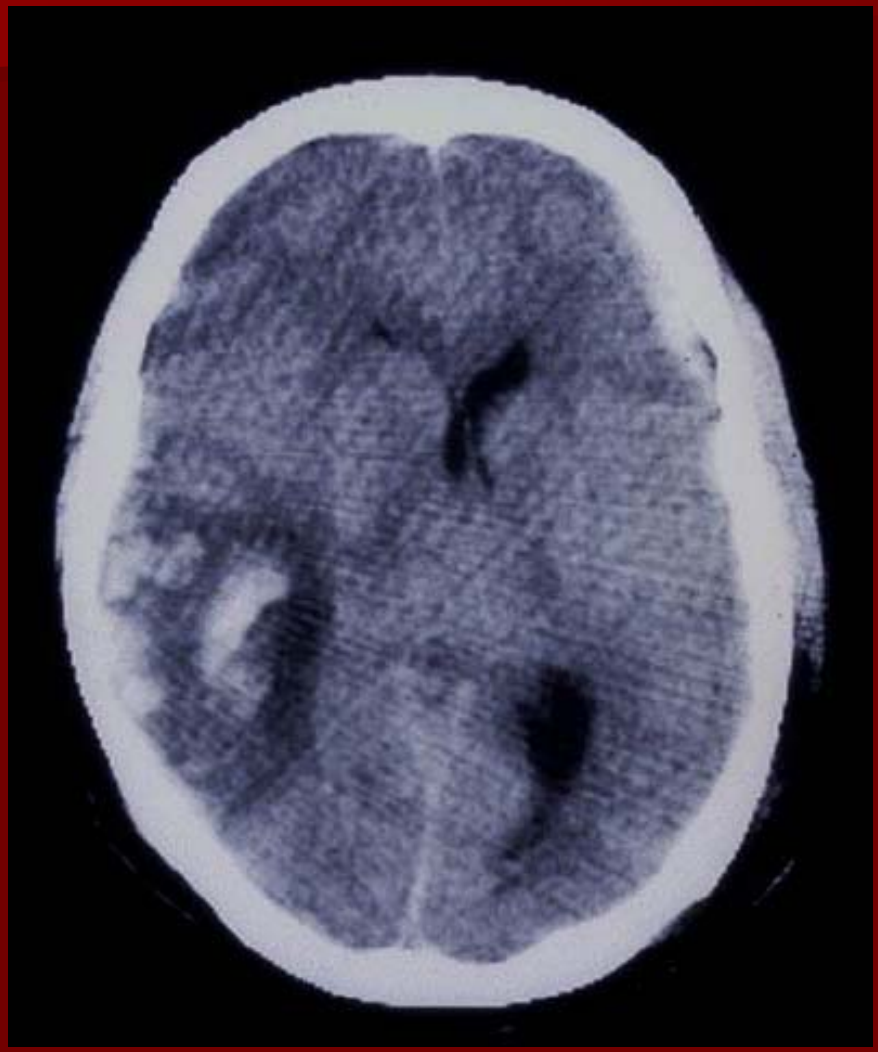
Neurologic Trauma

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

Neurologic Trauma

- Head injury evaluation
  - AMPLE—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

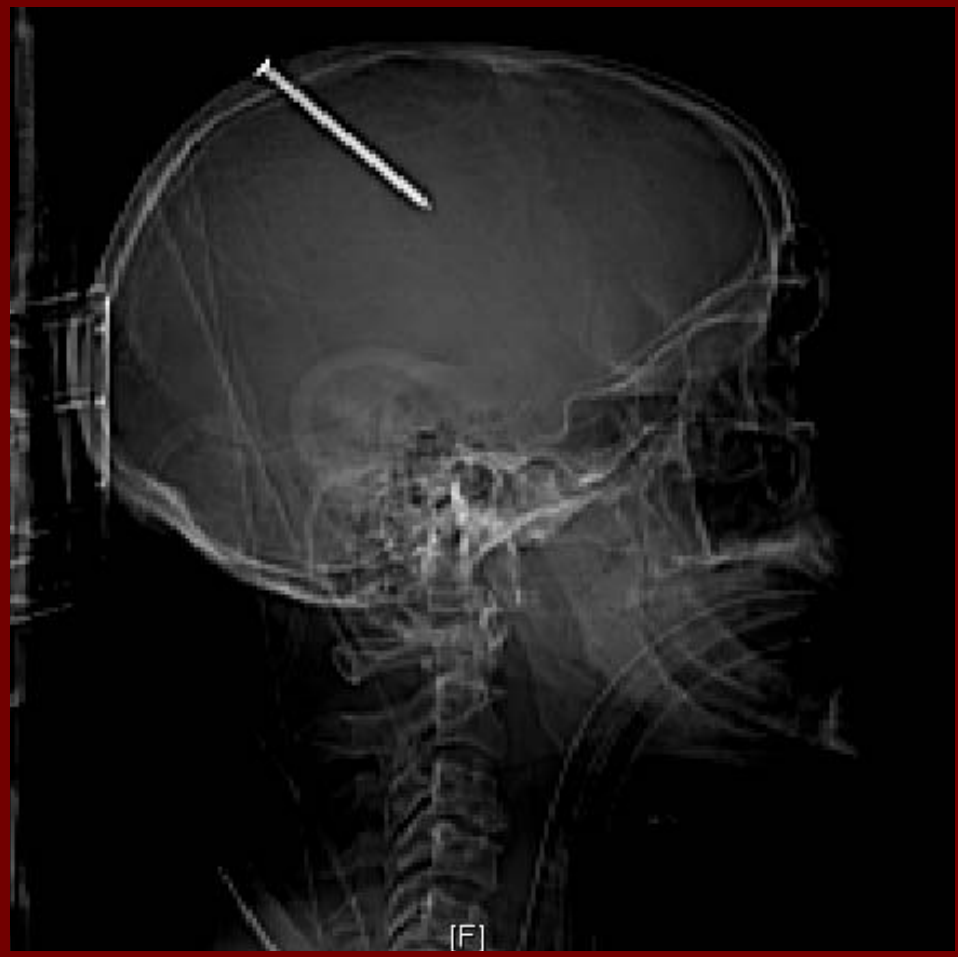
Neurologic Trauma



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

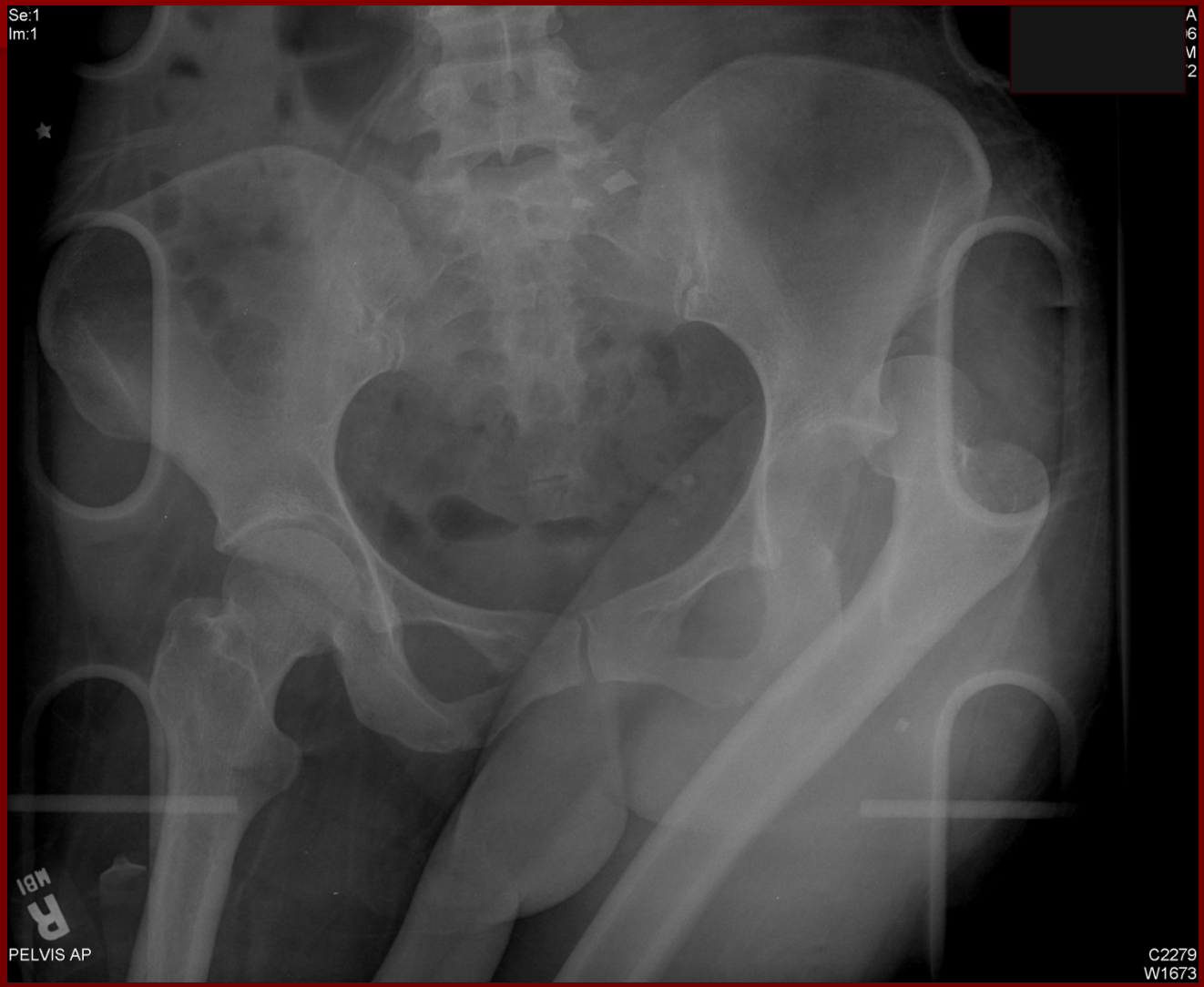
- Life-threatening extremity injuries include severe open fractures, proximal amputations, major crush injuries, and multiple fractures
- Knowledge of anatomy to predict associated injuries critical
- Can be associated with major blood loss
- Evaluation
  - Complete physical exam
  - Note wounds, deformities, 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



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?