Trauma Patient Management: The First Hour

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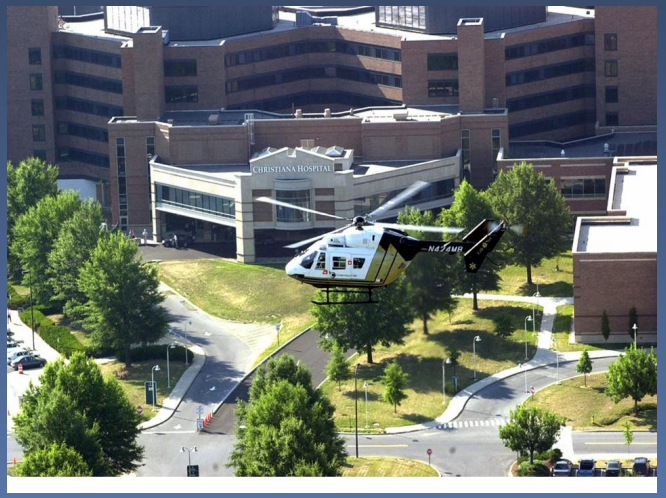
Objectives

- Describe how knowing the mechanism of injury can contribute to trauma patient management
- Discern trauma resuscitation priorities for the critically injured patient
- Identify effective techniques to control external hemorrhage



Mechanism of Injury

- Mechanism of injury can help to:
  - Explain types of injury
  - Predict eventual outcome
  - Identify possible injury combinations

Mechanism of Injury

- Blunt Trauma can result from:
  - Motor vehicle collisions
  - Falls
  - Assault
  - Sports
  - Industrial incidents
  - Blast force

Mechanism of Injury

- Penetrating trauma:
  - Stab wounds
  - Gunshot wounds
  - Shotgun wounds
  - Projectiles

Priorities of Trauma Resuscitation

Primary Survey & Simultaneous Resuscitation:

- ✓ABC vs. CAB? Control obvious hemorrhage first!
- ✓Airway / Cervical Spine / Stop the Bleeding!
- ✓Breathing / Ventilation
- ✓Circulation / Hemorrhage Control
- ✓Disability
- ✓Exposure / Temperature Control

Resuscitation Adjuncts

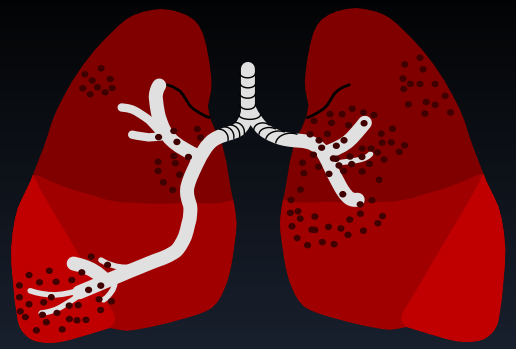
Diagnostic Studies

Secondary Survey & AMPLE History

A -- Airway / Cervical Spine

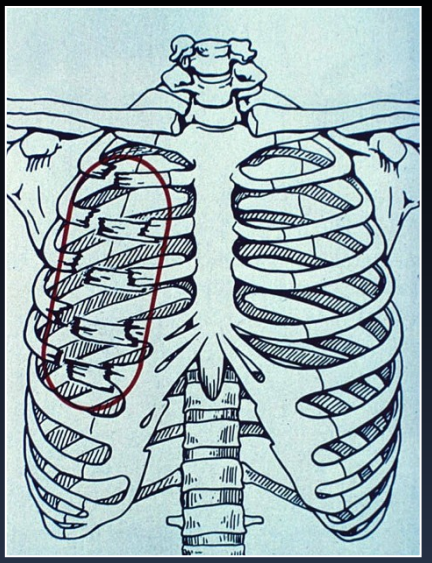
- Consider possible cervical spine injury
- Assess airway patency
- Perform appropriate airway maneuvers
  - Jaw thrust with manual, in-line stabilization of cervical spine
  - Remove debris / prevent aspiration
  - Consider airway adjuncts
  - Rapid sequence intubation
  - Surgical airway (cricothyrotomy) if indicated

B -- Breathing / Ventilation



- ✓ Assess neck & chest
- ✓ Neck: trachea & jugular veins
- ✓ Chest: Respiratory rate, depth, chest expansion, accessory muscle use, breath sounds, pain, crepitus / subcutaneous air
- ✓ Consider potential for injury & pre-existing pulmonary disease

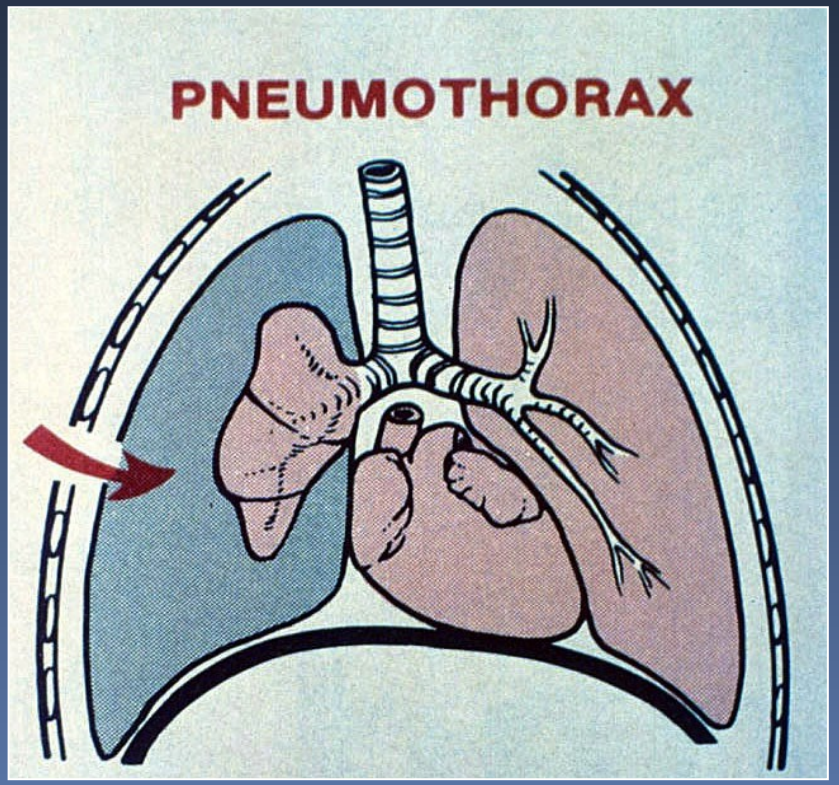
B -- Breathing / Ventilation



- Ventilatory Compromise
  - Rib fractures, flail chest
  - Pneumothorax / tension pneumothorax
  - Hemothorax
  - Neurologic injury
  - Consider need for chest decompression: Needle vs. tube thoracostomy

Breathing & Ventilation: Pneumothorax

- Blunt force transmitted to the lung can cause an explosion-type or burst injury within the lung
- “Paper Bag Effect”

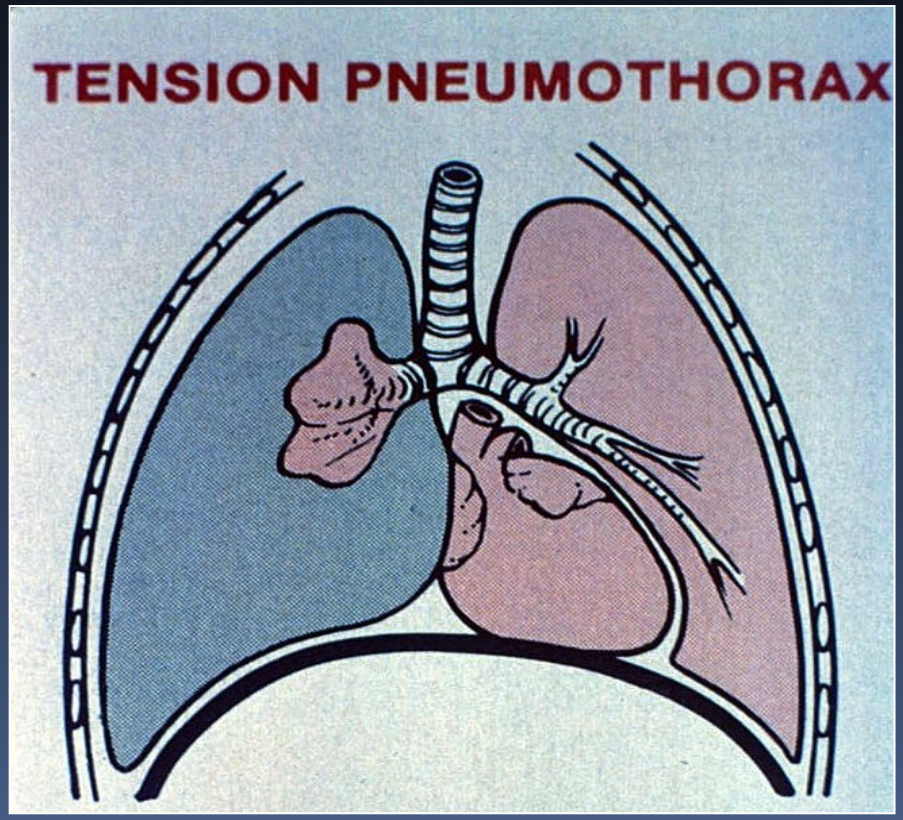


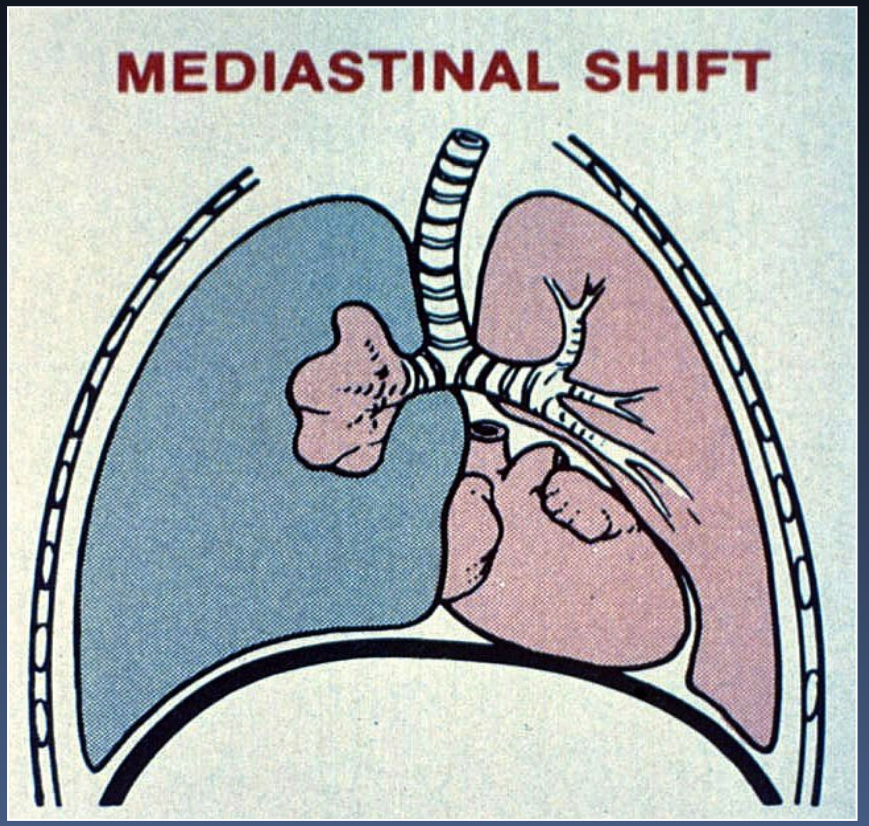
Breathing & Ventilation: Open Pneumothorax

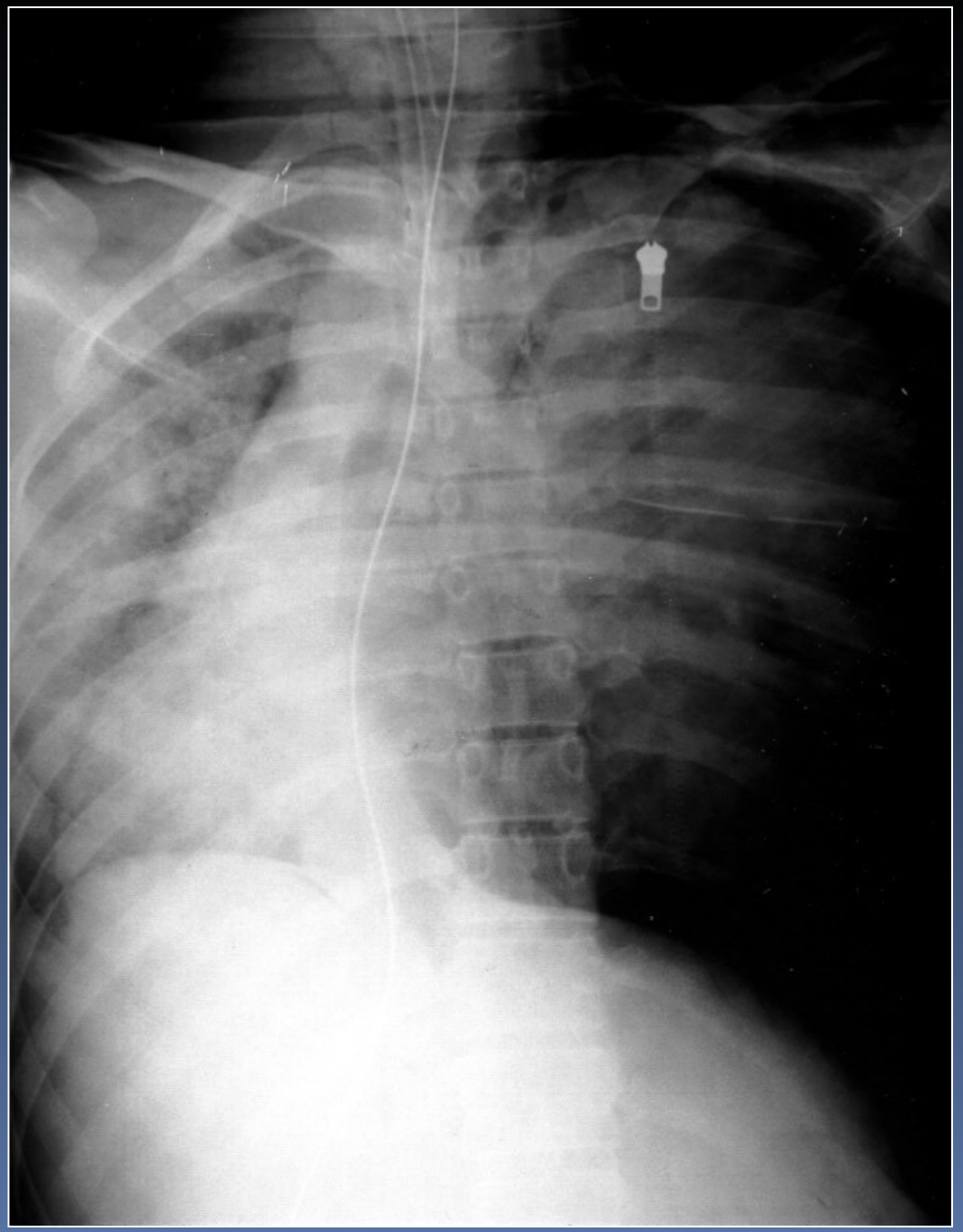
- Often due to penetrating trauma
- Produces “sucking” chest wound
- Occlusive dressing secured on 3 sides????
- Monitor for development of tension pneumothorax
- Prepare for chest tube insertion
- Operative intervention may be indicated

Breathing & Ventilation: Tension Pneumothorax

- Due to blunt or penetrating trauma, positive pressure ventilation (barotrauma)
- Air enters but cannot exit the pleural space
- Affected lung collapses
- Mediastinal shift occurs
- Venous return / cardiac output impaired
- Ventilation of normal lung impaired
- True emergency situation!


TENSION PNEUMOTHORAX


MEDIASTINAL SHIFT



Breathing & Ventilation: Tension Pneumothorax

- Clinical Presentation
  - Decreased to absent breath sounds over affected side
  - Profound respiratory distress
  - Hypotension / cardiovascular collapse
  - Distended jugular veins
  - Increased airway pressures (ventilator)
  - Decreased lung compliance (e.g., difficult to BVM / ventilate)
  - Tracheal deviation & cyanosis are late findings!

Breathing & Ventilation: Tension Pneumothorax

- Treatment
  - Immediate chest decompression
    - Needle thoracostomy: 14 gauge IV catheter, 2nd intercostal space, mid-clavicular line
    - Tube thoracostomy
      - Chest tube drainage system

Resuscitation: Airway, Breathing, Ventilation

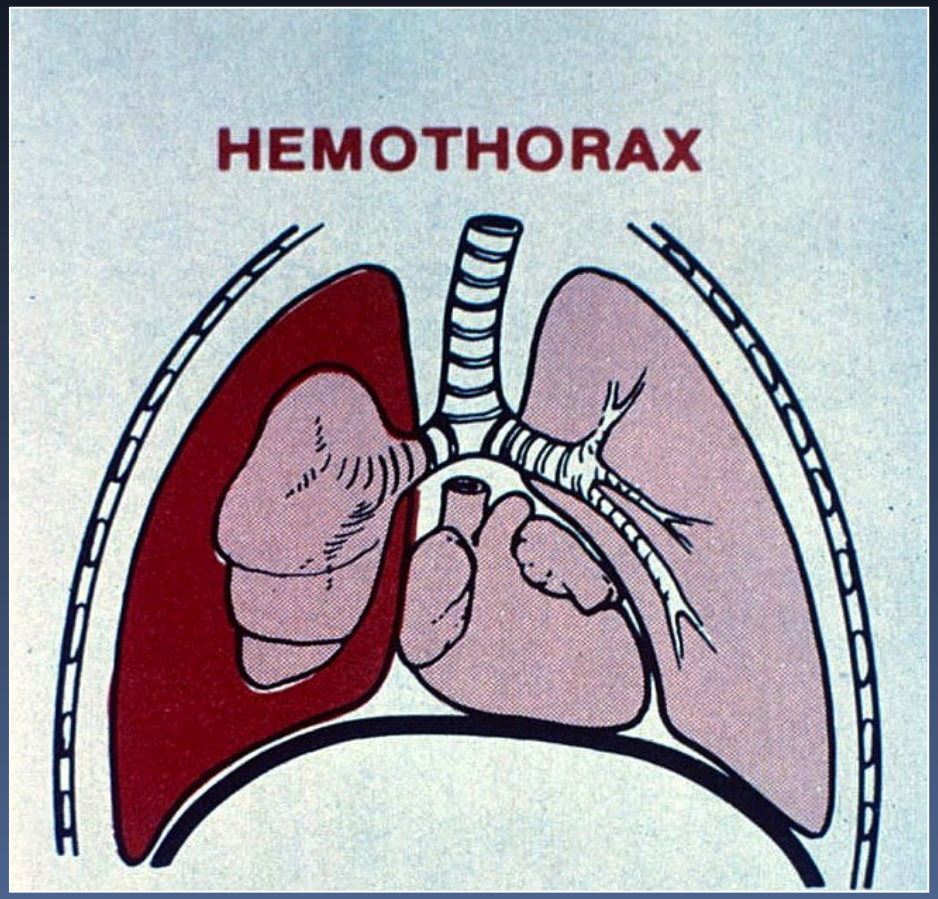
- Ensure oxygenation & ventilation
  - 100 % oxygen by non-rebreather mask
  - Assist ventilations with BVM as needed
  - Consider the need for airway adjuncts: endotracheal intubation or surgical airway
  - Gastric decompression

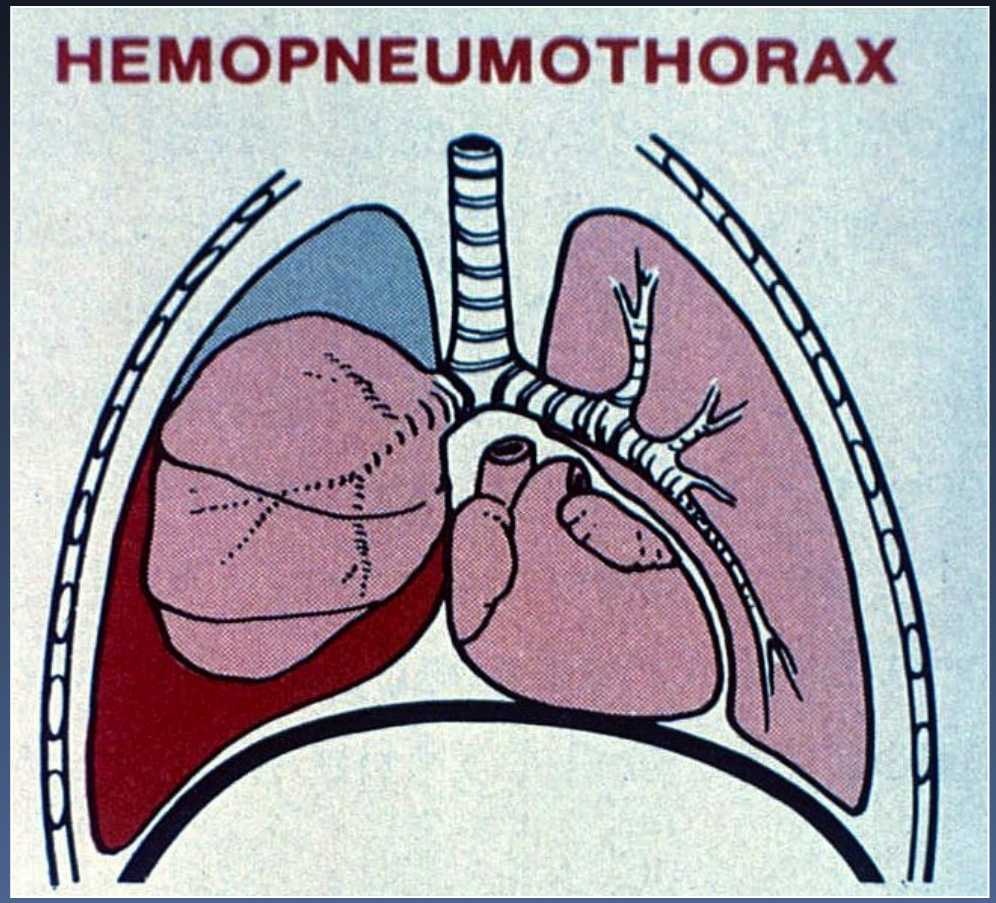
C -- Circulation / Hemorrhage Control

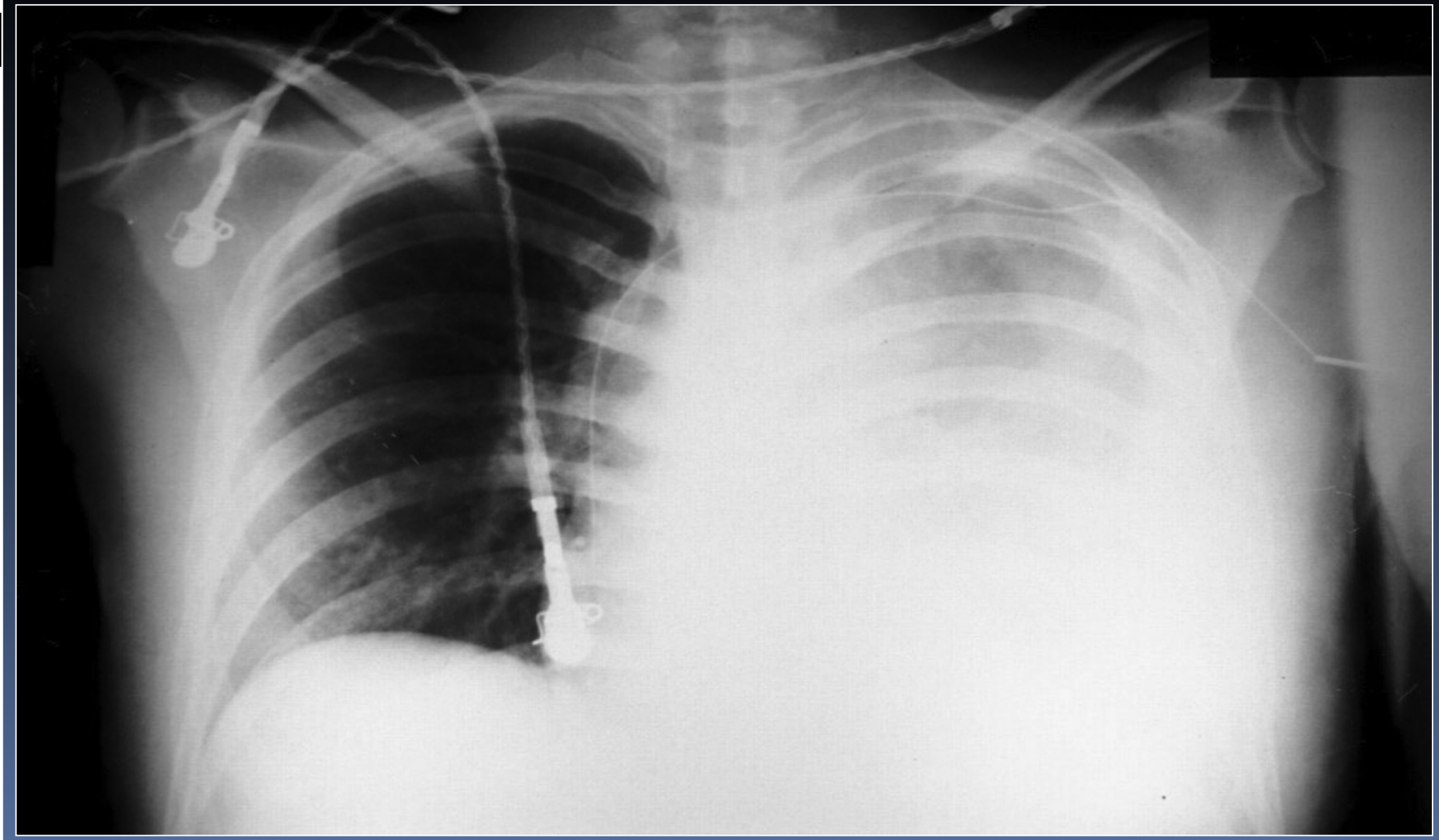
- ✓ Assess level of consciousness, pulses, bleeding sites, skin color & temp, heart rate, cardiac history
- ✓ Estimate BP
- ✓ Control hemorrhage
  - ➡ External: Apply direct pressure, tourniquet, or hemostatic dressing
  - ➡ Consider internal hemorrhage

Circulation: Massive Hemothorax

- >/= 1500 ml blood loss into pleural space
- Each hemithorax in an adult can hold approximately 2 liters
- Often due to disruption of the great vessels, intercostal or internal mammary arteries
- Patient will have decreased vital capacity in the presence of hypovolemic shock


HEMOTHORAX


HEMOPNEUMOTHORAX



Massive Hemothorax

- Treatment
  - Management of ABC's
  - Rapid volume replacement
    - Crystalloids
    - Blood
  - Chest tube insertion with autotransfusion-capable drainage system attached
  - Thoracotomy

Historically…

- We made the blood pressure look normal on the monitor (at least the trauma team felt better!)
- We viewed tourniquet use in the prehospital setting as "*the work of the devil*"
- But times have changed….

Circulation: Lessons from the Military

- “Haemostatic Resuscitation” approach to major hemorrhage
  - Focus on hemorrhage control
  - Application of hemostatic dressings & tourniquets
  - “Permissive hypotension” until bleeding is controlled
  - Minimal crystalloid use
  - Early transfusion of packed RBC’s with FFP & platelets in a 1:1:1 ratio
  - Recombinant Factor VIIa for severe hemorrhage

Circulation: Hemorrhage Control

- Use commercial tourniquet to control life-threatening limb hemorrhage (eg, amputation)
  - Apply directly to skin 2-3 inches above wound
  - Expose & clearly mark tourniquet site with time
  - Tighten to eliminate distal pulse; note time
  - Do not loosen to allow for limb circulation
  - Damage to limb is rare if tourniquet on for less than two hours

Circulation: Hemostatic Dressings & Combat Tourniquets

Circulation: Removing the Tourniquet

- Loosen tourniquet slowly & observe for bleeding
- Apply hemostatic dressing to wound if active hemorrhage
- If bleeding remains controlled, cover hemostatic dressing with a pressure dressing
- Leave loose tourniquet in place
- If bleeding is not controlled, re-tighten tourniquet

Circulation: Hemorrhage Control

- For compressible hemorrhage when tourniquet use is not possible, or as an adjunct to tourniquet removal, use a hemostatic agent:
  - Remove excess clot around wound
  - Pack hemostatic agent tightly into wound
  - Apply hemostatic agent with at least 3 minutes of firm, direct pressure
  - Cover / wrap area

Circulation

- Restore intravascular volume
  - Large-bore peripheral IV access lines (>/= 16 gauge) in at least 2 sites and limited infusion of warm crystalloid solutions of .9 NSS or RL (1-2 L)
  - Femoral or subclavian vein cannulation with 8.5 Fr introducer sheaths
  - Consider need for fluid infuser/warming device

Resuscitation Fluids

- 0.9% Normal Saline
  - Isotonic intravascular volume expander
  - Only solution compatible with blood products
  - Large volume infusions can cause fluid overload & hyperchloremic acidosis

Resuscitation Fluids

- Ringer's Lactate
  - Isotonic intravascular volume expander
  - Contains multiple electrolytes & lactate
  - Large volume infusions can cause fluid overload
  - Can promote lactic acidosis in prolonged hypoperfusion with decreased liver function
  - Lactate metabolizes to acetate; may produce metabolic alkalosis when large volumes are infused

Blood Component Therapy

<u>Packed Red Blood Cells</u> (PRBCs)

- Prepared by removing plasma from whole blood
- Increase O_2 carrying capacity
- Volume = 300 - 390 ml per unit
- 1 unit raises Hgb approx. 1 g/dl
- Contains citrate preservative (CPD-A)
- Devoid of clotting factors & platelets
- Stored packed RBC's are acidic at pH 7.16 at time of collection; pH drops to 6.87 at 21 days

Blood Component Therapy

- For emergent transfusion, uncrossmatched, Type O blood (Universal Donor) blood is used:
  - Rh negative: females
  - Rh positive: females beyond child-bearing years & males

Blood Component Therapy

Fresh Frozen Plasma

- Contains all clotting factors except platelets
- 1 unit of FFP contains 0.5 g fibrinogen (equivalent to 2 units cryoprecipitate)
- Takes 20 - 30 minutes to thaw

Blood Component Therapy

Platelet Pheresis

- Derived from a single donor – platelets are removed & RBC's & plasma are then returned to donor
- Conventional indication: thrombocytopenia (platelet count < 50,000 to 100,000)

Blood Component Therapy

Cryoprecipitate

- Fibrinogen is the factor most rapidly depleted in hemorrhagic shock
- Cryoprecipitate contains von Willebrand-factor/VIII complex, factor XIII and 0.25 g of fibrinogen per unit
- Takes 15 - 30 minutes to thaw
- Indication: fibrinogen < 100 mg/dl

BLOOD AVAILABILITY:
Blood Products & Preparation Times

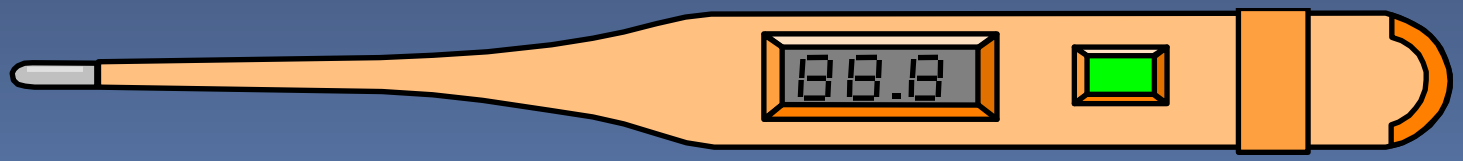
Un X-matched blood	7 minutes
Type-Specific blood	15 minutes
Type & X-matched blood	30 - 40 minutes (rare antibodies increase time!)
FFP	20 - 30 minutes
Cryoprecipitate	20 - 30 minutes
Platelets	7 - 10 minutes

Massive Transfusion (MT)

- Definition: Blood loss necessitating replacement of 10 or more units of blood within 24 hours
- Indicated for hemorrhagic shock
- Requires extensive blood banking resources
- Associated with high mortality
- The “Triad of Death” or “Bloody Vicious Cycle” of hypothermia, coagulopathy & acidosis are highly linked to mortality in MT

Complications of Massive Transfusion

- Hypothermia
  - Banked blood stored at 4 C
  - High risk with massive transfusion
  - Causes impaired oxygen delivery at tissue level (shifts oxyhemoglobin dissociation curve to left), cardiac arrhythmias, impaired cardiac output & coagulopathy
  - Fluid / blood warmers must be used
  - Temperature must be measured



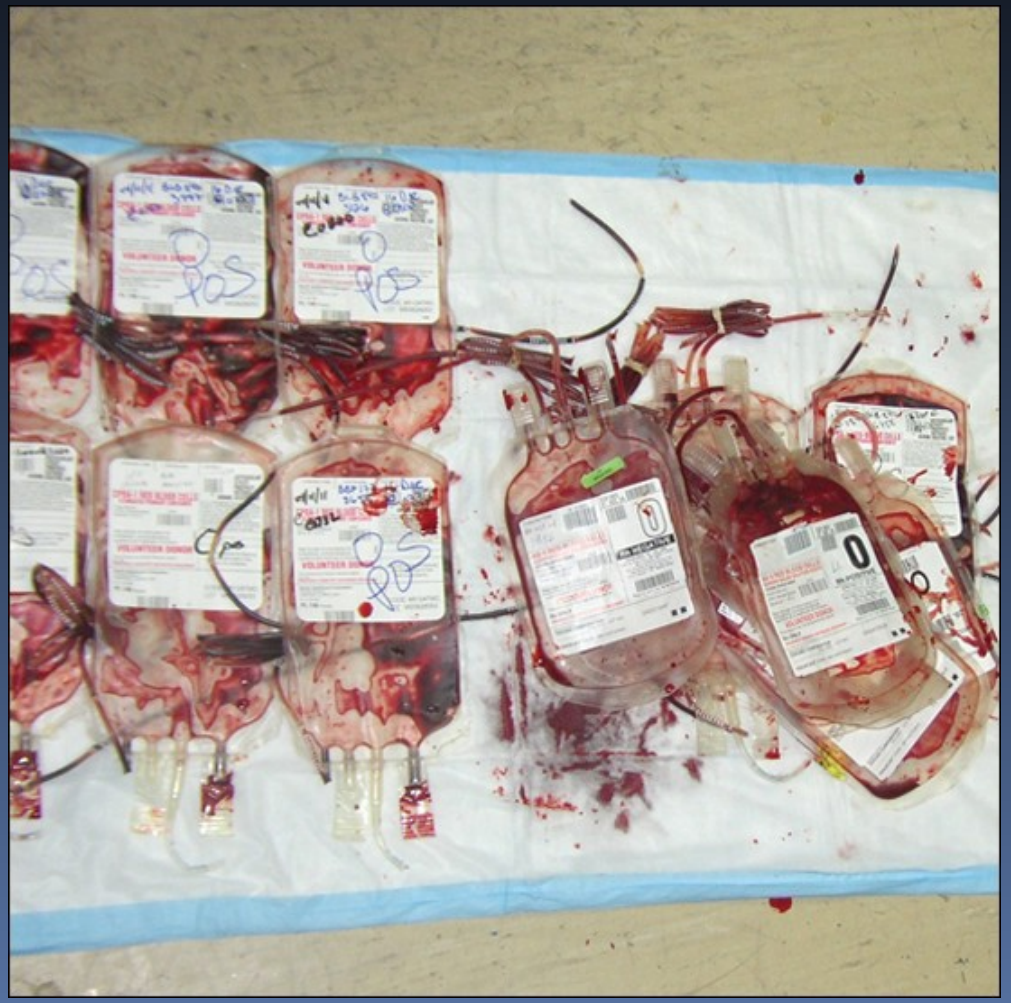
Complications of Massive Transfusion

- Coagulopathy
  - Hypothermia
  - Acidosis

  } Clotting factors are enzymes; impaired by acidemia & temp <36 C
  - Dilution of coagulation factors from replacement of shed whole blood with crystalloids & factor- & platelet-poor components
  - Thrombocytopenia
  - Uncorrected shock
  - DIC

Complications of Massive Transfusion

- Increased infection risk from immunodilution, possibly contributing to acute lung injury / respiratory distress syndrome, systemic inflammatory response syndrome (SIRS), & multi-organ failure



Complications of Massive Transfusion

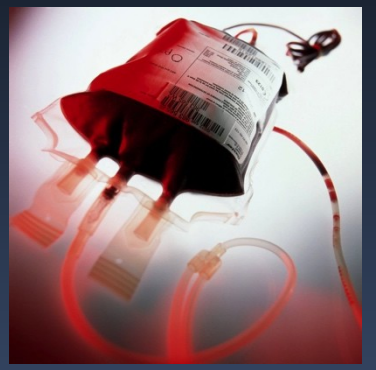
- Electrolyte Imbalance
  - Hypocalcemia: due to citrate-containing blood preservatives binding with ionized calcium (most common in FFP & platelet transfusions due to higher citrate content); causes tetany, arrhythmias, hypotension & decreased cardiac contractility.
  - Hyperkalemia: from infusion of old or damaged RBCs (may result from use of high volume infusers); can produce arrhythmias & cardiac arrest

Complications of Transfusion

- Hemolytic reactions:
  - ➔Sudden, diffuse microvascular bleeding from multiple sites, DIC
  - ➔Hypotension, tachycardia, shock, urticaria, dyspnea, fever, back pain, chest pain
  - ➔Hemoglobinuria: (+) urine dipstick for blood; acute renal failure

Management of Hemolytic Transfusion Reactions

- D/C transfusion immediately; save blood for analysis
- IV crystalloids to maintain UO > 100 ml/hr
- Mannitol or furosemide to induce diuresis
- Vasopressors for hypotension
- Urine sample for free hemoglobin
- Blood samples for electrolytes, DIC screen, BUN, creatinine, hemolysis, T & C, hemolytic antibody (Coombs' test)



Identify & Control Ongoing Blood Loss

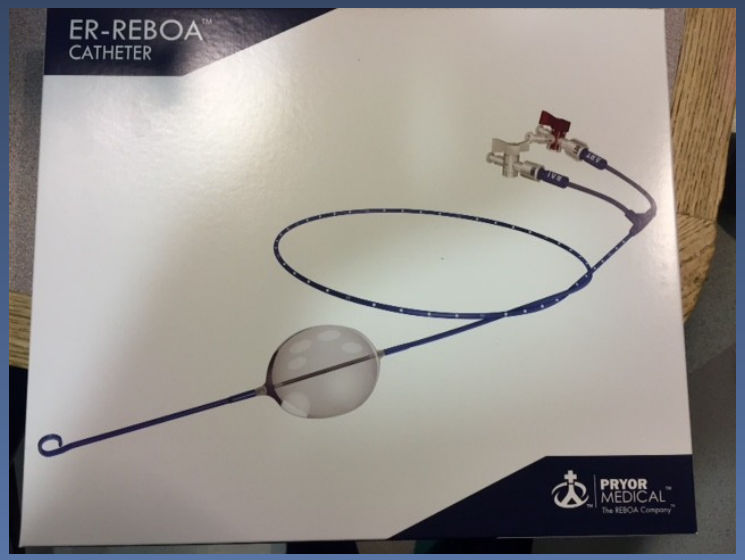
- Continuous re-assessment
- Consider common causes
  - External injury
  - Retroperitoneal injury
  - Intraperitoneal injury
  - Vascular trauma
  - Pelvic fracture / multiple fractures
- Anti-coagulation reversal
- REBOA

REBOA for Hemorrhagic Shock

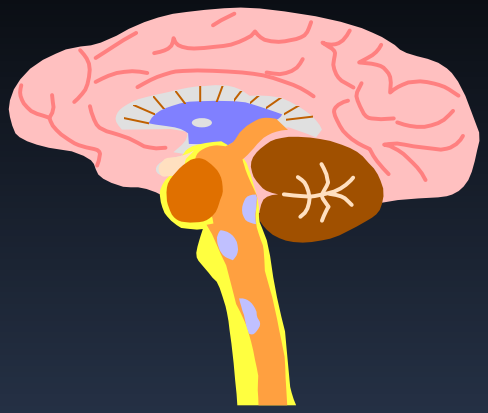
- REBOA: Resuscitative Endovascular Balloon Occlusion of Aorta
  - Used to stop life-threatening, non-compressible hemorrhage (chest, abdomen, pelvis) in lieu ED thoracotomy / aortic cross-clamping
  - Option in "damage control" resuscitation pending definitive, surgical hemostasis in the *peri-arrest* patient
  - A less invasive & proactive approach
  - Indications: Refractory hemorrhagic shock from blunt or penetrating abdominal or pelvic trauma without evidence of cardiac injury on FAST exam

REBOA

- Femoral artery accessed using a vascular sheath
- Balloon catheter inserted to appropriate section of aorta (zone)
- Balloon inflation to occlude blood flow
- Patient transported directly to OR for definitive repair



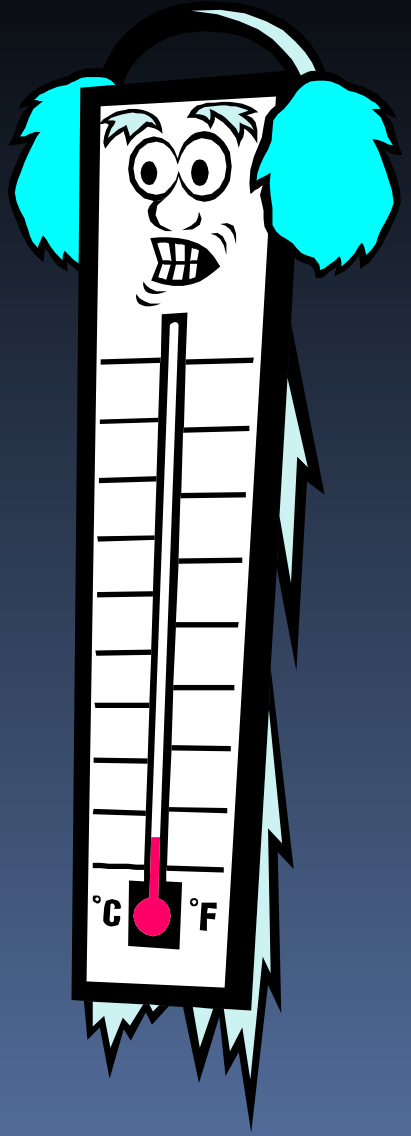
D -- Disability



- ✓ Baseline assessment: LOC
  Glasgow Coma Scale 3-15
- ✓ Pupil response
- ✓ Motor / sensory function
- ✓ Consider trauma, toxic & metabolic causes

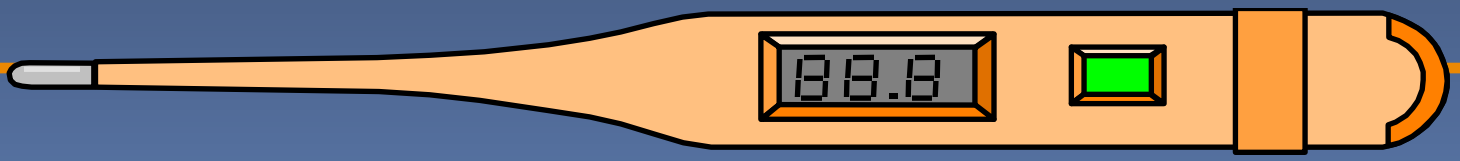
E -- Exposure

- ✓ Assess all body areas
- ✓ Cut away clothing
- ✓ Prevent hypothermia!



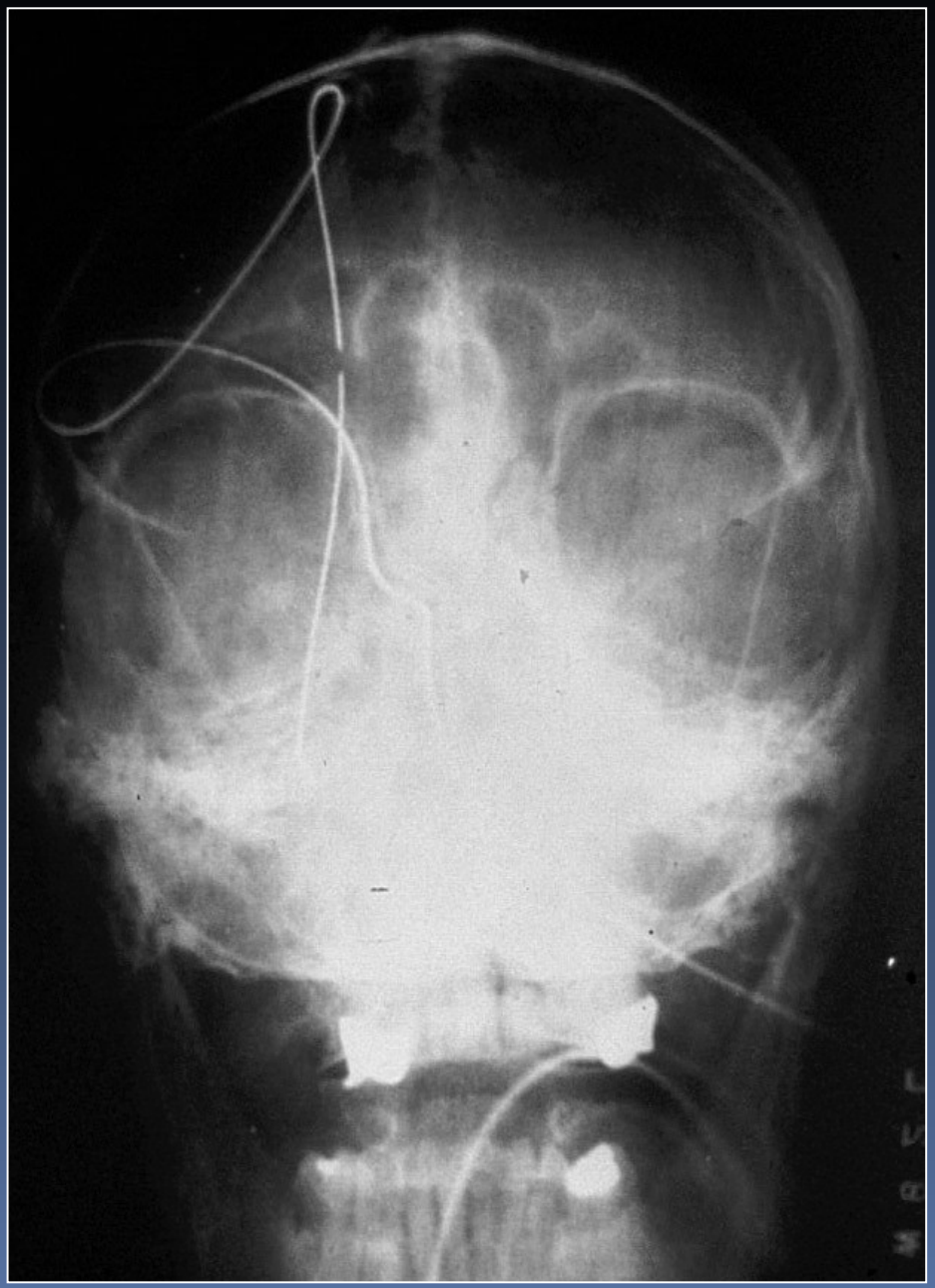
Exposure / Temperature Control

- Establish / maintain normothermia
  - Monitor body temperature
  - Set room temperature to 75-80° F.
  - Remove wet clothing / sheets; cover with warm blankets
  - Infuse fluids and blood products through rapid warming devices
  - Use additional warming measures as needed



Resuscitation Adjuncts

- Cardiac & physiologic monitoring devices
- Urinary catheter: Caution: Assess urinary meatus for blood & assure rectal / genital exam is performed prior to insertion
  - Urinary drainage bag / urimeter to monitor urine output
  - Test urine for blood
- Gastric decompression: Prevent abdominal distension, vomiting & aspiration
  - Use OG tubes in patients with head or maxillofacial injury

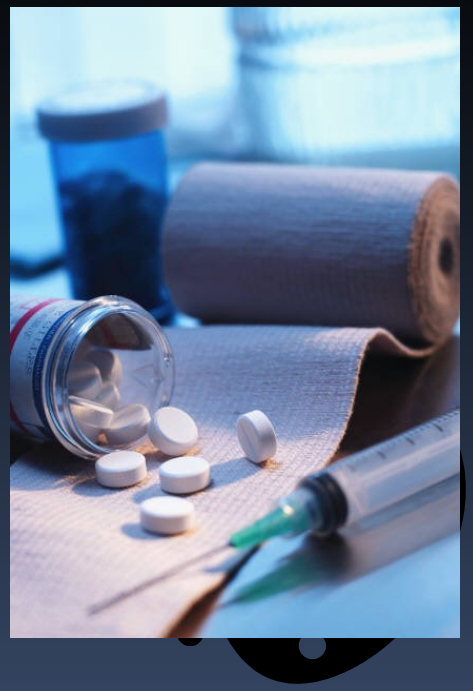


Secondary Survey

- Occurs after primary survey when resuscitation is underway
- Complete head-to-toe assessment
  - Include front & back of patient
- Fracture stabilization
  - Decreases pain & blood loss
  - Assess sensory / motor / vascular status before & after splinting

Physical Exam / Assessment

AMPLE History



- ✓ A: Allergies
- ✓ M: Medications
- ✓ P: Past medical history
- ✓ L: Last meal
- ✓ E: Events / Environment related to the injury

*Collect the history from the patient, EMS, police, and/or the family when available

Diagnostic Studies

- Obtain diagnostic studies:
  - Laboratory studies
  - Plain film radiography
  - Ultrasound / FAST
  - CT scans
    - CT scanning is used to define injuries & plan care

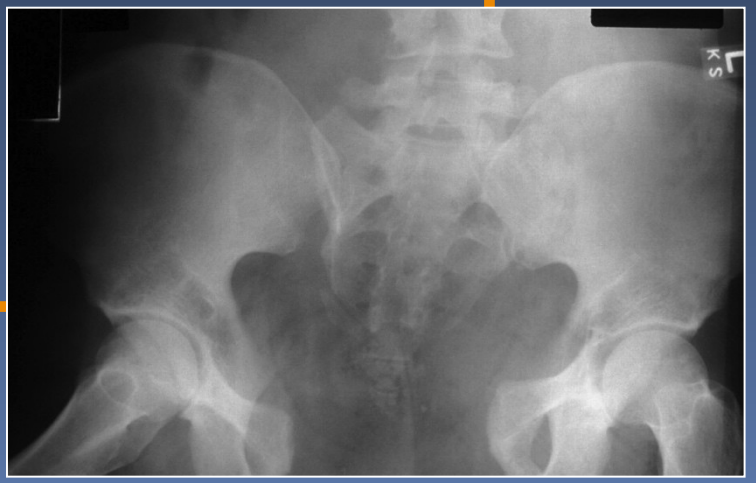
Diagnostic Studies

- Baseline laboratory specimens
  - Type & Crossmatch
  - CBC
  - Coagulation profile
  - TEG: Thromboelastogram
  - Electrolytes, glucose, serum lactate
  - Arterial blood gases: pH, base deficit/excess

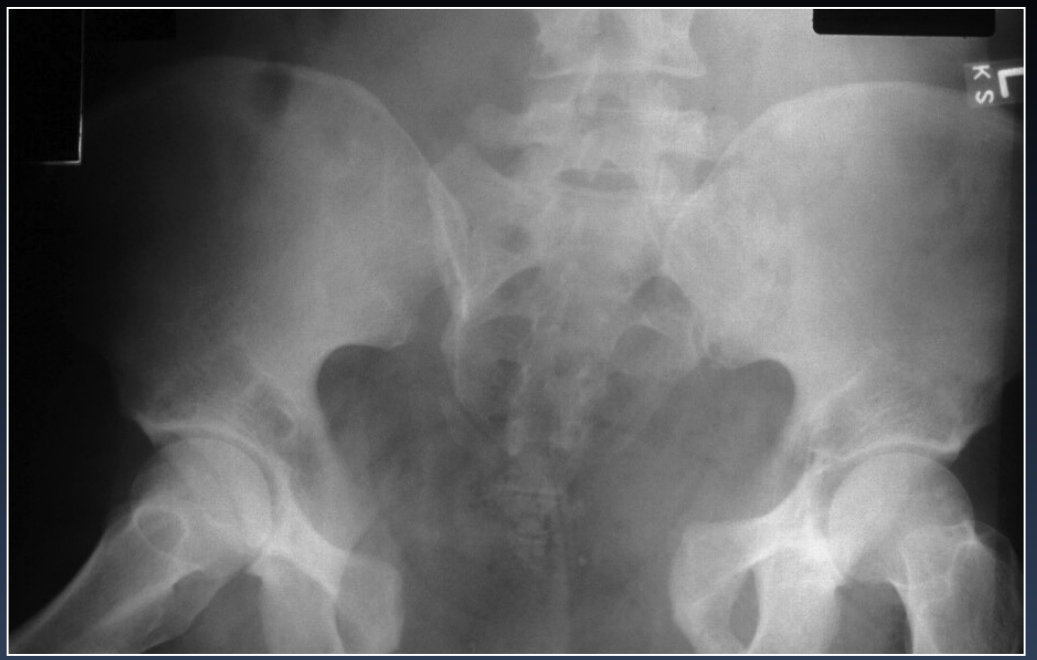
  Note: initial H & H may appear normal despite acute hemorrhage; equilibration takes time!

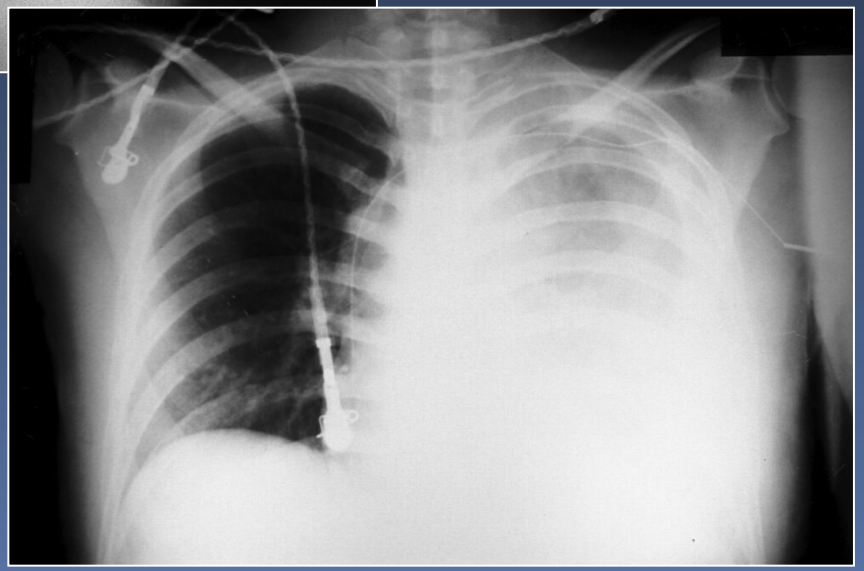
Diagnostics: Identify & Control Ongoing Blood Loss

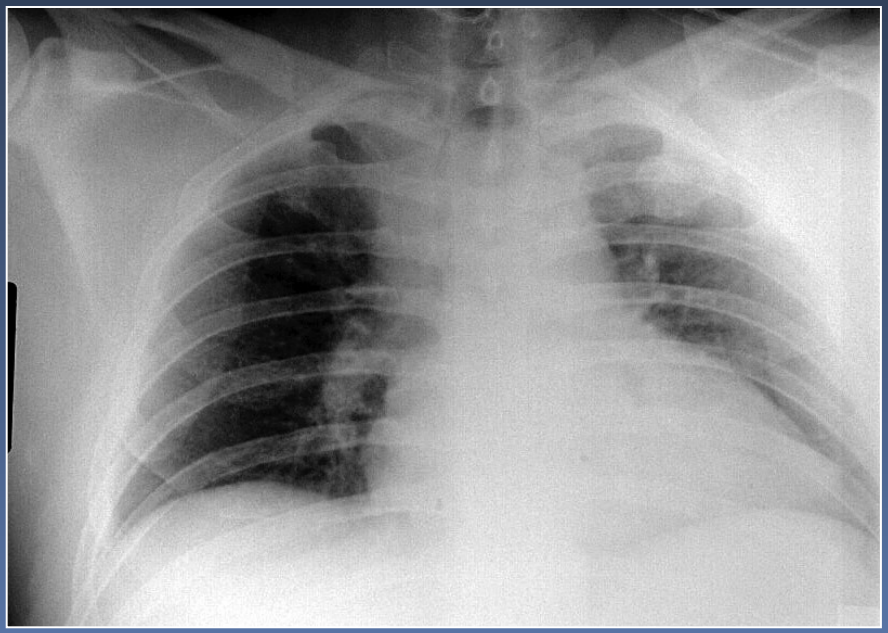
- Physical examination / assessment
- Chest & pelvic x-rays
- Ultrasound (FAST)
- CT Scanning



Radiography

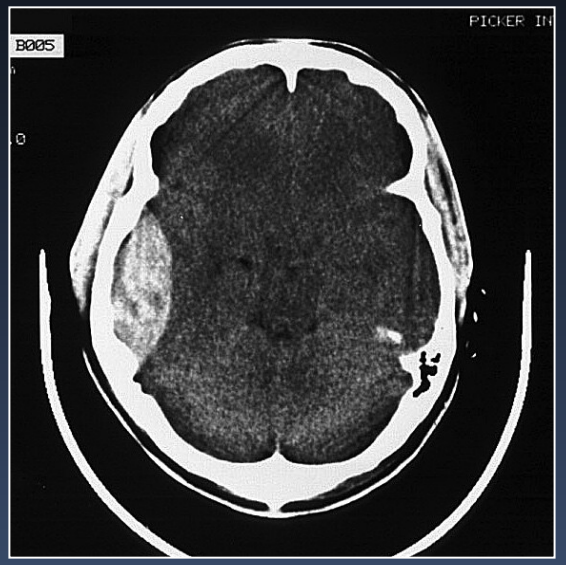


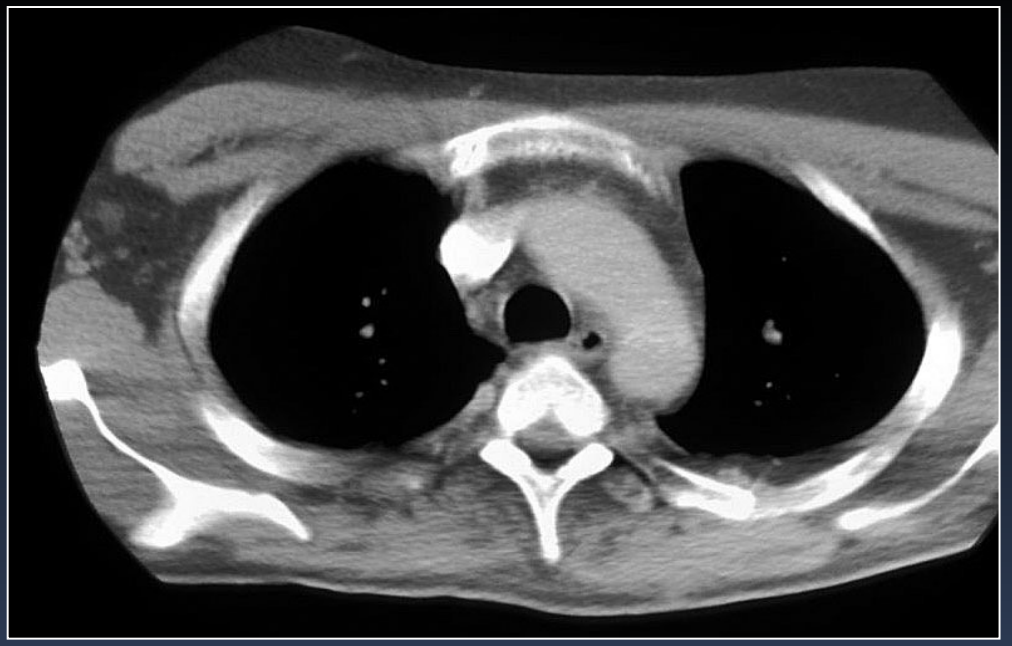




FAST: Focused Assessment Sonography for Trauma

CT Scanning





Definitive Care

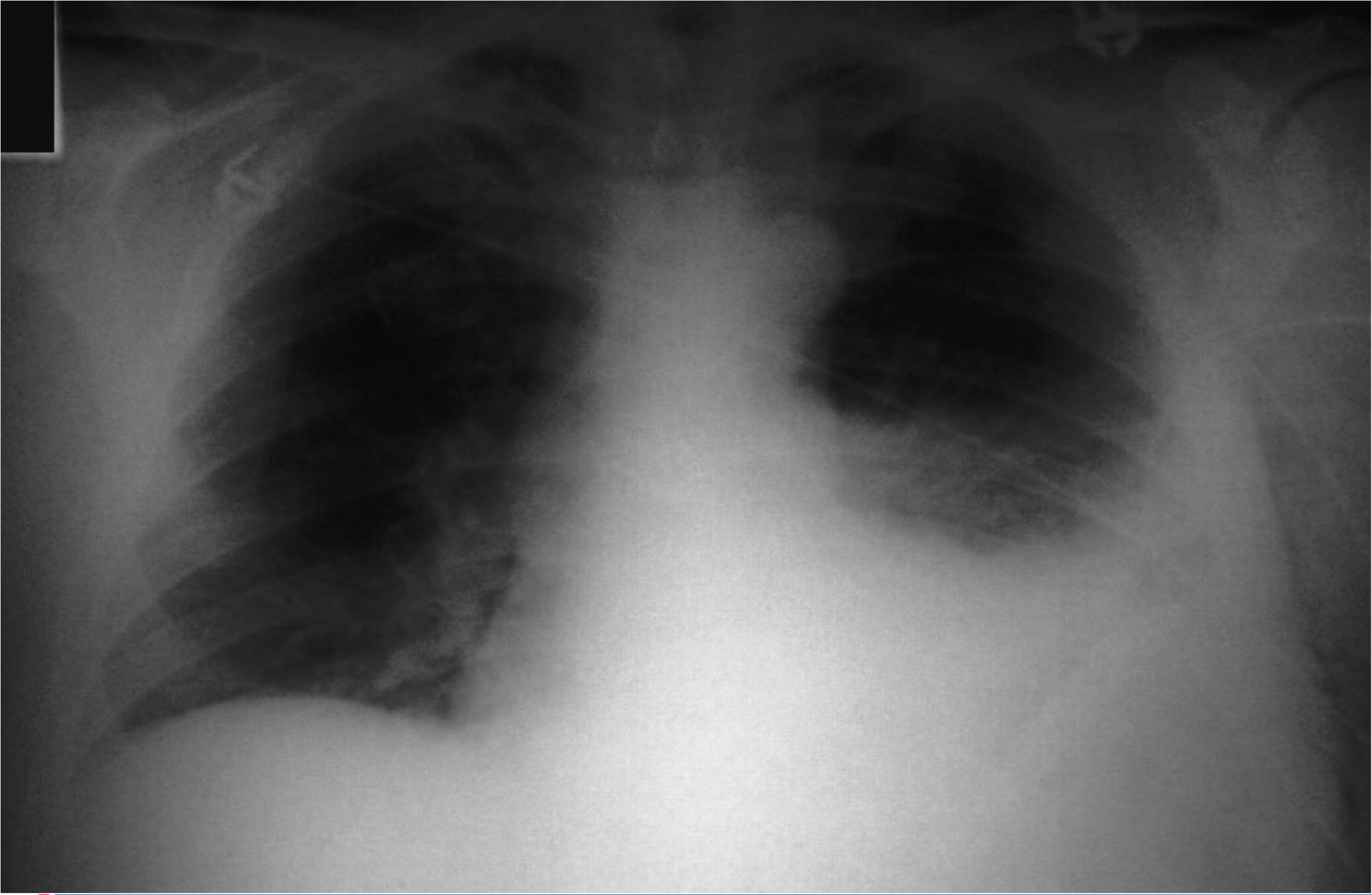
- Stabilization and transfer
  - Trauma center
  - Operating room
  - Critical care unit
  - Transitional care unit
  - Surgical unit

Outcome Indicators of Adequate Resuscitation

- Hemodynamic / renal parameters WNL
- Core body temperature 36 - 37 C
- Serum lactate < 2 mmol/L
- Base deficit </= 5
- Arterial pH 7.35 - 7.45
- Hgb > 9 (based upon individual needs)
- Ionized Ca WNL; Serum K 3.5 - 5.3
- Coagulation profile WNL

Challenge Yourself

- Look at the next chest radiograph
- Is it normal?
- What other study might be helpful given the patient's presentation?



Thank You!

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