Blast Injuries: Blast Lung

- Clinical manifestations
  - Tachypnea
  - Hypoxia
  - Cyanosis
  - Apnea
  - Wheezing
  - Decreased breath sounds
  - Hemothysis
  - Cough
  - Chest pain
  - Dyspnea
  - Hemodynamic instability

- Treatment
  - High flow oxygen sufficient to prevent hypoxemia via non-rebreather mask
  - CPAP
  - Endotracheal intubation
  - Judicious fluid administration (similar to that of pulmonary contusion)

Blast Injuries: Head

- Primary blast waves can cause concussions or mild traumatic brain injury (MTBI) without a direct blow to the head
Consider the proximity of the victim to the blast particularly when given complaints of:
- Loss of consciousness
- Headache
- Fatigue
- Poor concentration, lethargy, amnesia, or other constitutional symptoms

Symptoms of concussion and post traumatic stress disorder (PTSD) can be similar

Blast Injuries: Ear

- Tympanic membrane rupture indicates exposure to an over pressurization wave. It may be found in victims with severe pulmonary, intestinal, or other injuries, or it may be found in isolation. Its presence does not indicate that more sinister blast injuries exist.
- Ear injuries may include not only TM rupture, but also ossicular disruption, cochlear damage, and foreign bodies.
- Presentation: acute hearing loss (conductive, sensorineural)
- Findings: auditory canal debris, tympanic membrane rupture, ossicular disruption, cochlear damage
- Treatment: observation; 50-80% of ruptured tympanic membranes heal;
sensorineural hearing loss often permanent

- **Blast Injuries: Abdomen**
  - Abdominal injuries (also called blast abdomen) include abdominal hemorrhage and abdominal organ perforation
  - Clinical manifestations include:
    - Abdominal or testicular pain
      - Tenesmus
      - Rectal bleeding
      - Solid organ lacerations
      - Rebound tenderness
      - Guarding
      - Absent bowel sounds
      - Signs of hypovolemia
      - Nausea
      - Vomiting

- **Blast Injuries: Combined Injuries**
  - Combined injuries, especially blast and burn injury or blast and crush injury, are common during an explosive event.
  - Avoid tunnel vision during initial assessment
  - Treatment protocols are often contradictory
  - Blast lung vs. burn injury, blast lung vs. crush injury
  - Judicious fluid administration for adequate tissue perfusion without
volume overload may be required in the multiple injured patient with blast lung
- Presence of additional injuries complicates administration, rate, selection of fluids
- Typical confined space (e.g., a bus) injuries
- Primary—blast lung, intestinal rupture, TM rupture
- Secondary—penetrating injury to head, eye, chest, abdomen
- Tertiary—traumatic amputation, fractures to the face, pelvis, ribs, spine
- Quaternary—crush injuries, superficial and partial to full thickness burns

Military Experience
- U.S. Military has significant experience in dealing with blast and explosive injuries
- Military has been quick to seek and adopt new strategies in treating hemorrhage, the leading cause of preventable death
- Mortality rates dramatically lower for the current conflict
- Death Rates After Wounding
  - Revolutionary War
    - 42%
  - WWII
    - 30%
- Korean War
  ~25
- Vietnam War
  ~25
- Persian Gulf War
  ~25
- Global War on Terror (GWOT)
  <10

- Medical Advances from the GWOT
  - Expanded use of Damage Control Surgery
  - Whole blood
  - Tourniquets
  - Hemostatic agents
  - Hemostatic dressings
  - Damage Control Surgery
  - Technique known for 20 years, but slow to be accepted

- Central tenet: Avoid the “Deadly Triad”
  - Hypothermia
  - Coagulopathy
  - Metabolic acidosis
  - Each condition worsens both of the others

- Damage Control Surgery
  - Stop the bleeding
  - Remove major contaminants
  - Wounds left open to avoid abdominal compartment syndrome
  - “Pack ‘em and wrap ‘em”
  - Transfer to ICU, Resuscitate in ICU:
- Normalize BP, core temp, coag factors
- Return to OR 12-18 hours for definitive surgery

**IV Hemostasis**
- INR>1.5 on arrival predictive of need for massive transfusion (MT)
- Fresh thawed plasma best resuscitation fluid in MT
- Optimum ratio of plasma to crystalloid 1:1 to avoid clotting factor dilution >50%
- Less crystalloid (acidotic, inflammatory, adverse effects on coagulation)
- Hextend (a colloid) preferable
- Use of fresh whole blood
- Early use of cryoprecipitate
- Recombinant Factor VIIa (rFVIIa)

**Tourniquets**
- Liberal use encouraged for any significant extremity hemorrhage
- No adverse events seen in cases when applied inappropriately
- Apply early (“first resort not last resort”)
- Every soldier carries at least one at all times

**Hemostatic Dressings**
- Key to avoiding coagulopathy from MT is to control bleeding in the first place
- Primarily used for non-extremity hemorrhage
- Dressings applied with pressure x 5 minutes; patient wrapped and transported
- HemCon (chitosan)
  - Originally available as a bandage
  - Now available in roll that can be stuffed into wound
- QuikClot
  - Very exothermic (up to 147 deg F)
  - Difficult to debride
  - Gauze sack – easily removed from wound
  - New Advanced Clotting Sponge (ACS)

**Special Considerations: Pregnancy**
- Injuries to the placenta are possible and must be detected
- Second or third trimester of pregnancy should be admitted for continuous fetal monitoring (22 weeks)
- The placental attachment is at risk for primary blast injury
- Screening test for fetal-maternal hemorrhage in second or third trimester of pregnancy (KB test)
- Positive test requires mandatory pelvic ultrasound, fetal non-stress test monitoring, and obstetrics/gynecology (OB/GYN) consultation.
- **Special Considerations: Children**
  - History of event or patient’s complaints may be difficult to obtain.
  - Pulmonary contusion is one of the most common injuries from blunt thoracic trauma. The injury may not be clinically apparent initially and should be suspected when abrasions, contusions, or rib fractures are present. A chest x-ray is essential in diagnosis especially when blast lung is suspected.
  - Specialized equipment
  - Identification of regional pediatric trauma facilities

- **Special Considerations: Elderly**
  - May be at a higher risk of mortality and the in-hospital stay may be longer and more complicated
  - Orthopedic injuries may be more prevalent
  - Blunt chest trauma should be of special consideration
  - Decontamination methods may need modification due to limited mobility
  - Technical decontamination of medical equipment such as wheelchairs, walkers and other walking aids may be needed

- **Special Considerations: Disabled**
  - Consideration should be given to patients with underlying medical conditions
Untreated or inadequately treated fractures may lead to severe and long lasting disabilities

**Discussion Topics**
- Surge Capacity Issues
- Hospital after Madrid bombing saw 312 patients in 2.5 hours
- Need to surge: CT, OR suites, staff, and supplies (blood, etc.)
- Hidden nature of injuries can lead to dangerous overtriage and undertriage