Chapter 18: Penetrating Trauma

Introduction to Penetrating Trauma

- 28,000 Deaths in US annually due to ____________________________________.
- Mechanisms of penetrating trauma
  - Knives, Arrows, Nails, etc
- Understanding principles of energy exchange increase the Index of ____________________________________ associated with the MOI

Physics of Penetrating Trauma

- Greater the mass the greater the energy
  - Double mass = ____________________________________ KE
- Greater the speed the greater the energy
  - Double speed = ___________x increase KE

Physics of Penetrating Trauma

- Small & Fast bullet can cause greater damage than large and slow.
- Different bullets of different ____________________________________ traveling at different speeds cause different injuries:

Physics of Penetrating Trauma

Energy and Velocity

- Low Energy/Low Velocity
  - Knives and arrows
- Medium Energy/Medium Velocity Weapons
  - Handguns, ____________________________________ , low-powered rifles
  - 250-400 mps
- High Energy/High Velocity
  - ____________________________________ Rifles
  - 600-1,000 mps

Physics of Gun Shot Wound (1 of 2)

- Bullet ____________________________________ as it travels down barrel
  - Rifling in barrel allows bullet to travel straight with slight yaw (wobble)
- Bullet departs barrel, spinning with a slight yaw
- Weapon forced backward and absorbs energy
  - ____________________________________

Physics of Gun Shot Wound (2 of 2)

- Remainder of energy propels bullet forward at a high rate of speed.
- Trajectory is curved due to ____________________________________
- As bullet strikes object, it slows and energy is ____________________________
  to object.
  - Law of conservation of energy

Law of Conservation of Energy

- Energy can be neither __________________________ nor destroyed
- Kinetic energy is transferred into __________________________ as it slows
- If a projectile remains in an object, then ALL it’s energy is transferred to the object
- If a projectile passes through an object, then the energy transferred to the object is equal to the kinetic energy just prior to entry __________________________ the
energy remaining in the bullet as it exits

Studies suggest that wounds from bullets are from two to four times more lethal than wounds from bullets.

Ballistics
Factors affecting energy exchange between a projectile and body tissue

- **Velocity**: Speed
  - : shape of the object as it comes toward you
  - : ability to maintain a course

- **Expansion & Fragmentation**: energy exchange at impact
- **Secondary Impacts**: due to deflection or absorption
- **Shape after** : affects the penetration power

Energy Dissipation (1 of 2)

- : wind resistance
- : formation of a partial vacuum and cavity within a semi-fluid medium

  - Size and shape of a projectile as it contacts a target
  - Larger the profile=greater energy exchange
  - Expansion and fragmentation results in damage

Energy Dissipation (2 of 2)

  - Allows for straighter trajectory
  - after striking object results in tumbling

Aspects of Ballistics (1 of 6)

Velocity

- Causes Trajectory
  - Faster = trajectory
  - = more curved due to gravity

Aspects of Ballistics (2 of 6)

Profile

- Portion of bullet you see as it travels towards you
  - Larger profile = energy exchange

  - Diameter of a bullet (ID of gun)
    - 0.22 caliber = 0.22 inches

- Bullets become as they pass from one medium to another.

Aspects of Ballistics (3 of 6)

Stability

- Bullet length bullet tumbling
  - Can reduce the accuracy of the shot
- Tumbling reduced by rifling in barrel (spinning)
  • Yaw
  - Gyroscopic effect on the center axis of the bullet that reduces tumbling
  • Tumbling of bullet once it strikes object
    - ____________________________ kinetic energy
    - ____________________________ tissue damage

**Aspects of Ballistics (4 of 6)**

Expansion & Fragmentation:
- Results in ____________________________ profile
- ____________________________
- Initial impact forces may result in fragmenting
- Greater ____________________________ damage

**Aspects of Ballistics (5 of 6)**

______________________________ Impacts
  • Bullet striking other objects can cause yaw and tumble
  • Body Armor (______________________________)
    - Transmits energy throughout entire vest resulting in blunt trauma
      - ____________________________ Contusion
      - Pulmonary Contusion
      - ____________________________ Fractures

**Aspects of Ballistics (6 of 6)**

Shape after impact
  • Handgun Ammunition = ____________________________ = Tumble
  • Rifle Ammunition = ____________________________ = Piercing

**Projectile Types**
  • Simple ____________________________
  • Semi-jacketed
    - ____________________________ point
  • Full ____________________________

**Lead Projectiles**
  • Oldest and ____________________________ to manufacture
  • Relatively soft and deformable
  • Often ____________________________ upon impact
  • Readily ____________________________ the barrel at higher muzzle velocity

**Semi-Jacketed**
  • Also referred to as ____________________________ point
    - “Dum-dum”
  • Designed to promote ____________________________

**Full Metal Casing (FMC)**
  • Prescribed by ____________________________ Convention
  • Theoretically creates ____________________________ tissue damage because it resists fragmentation

**Deformation**
  • Creates increased ____________________________ section.
• Promotes transfer of kinetic energy.
  • Geometry dictates that...
    - Twofold increase in diameter results in a __________________________ increase in area.
  • This process is (in theory) promoted by __________________________ jacket design.

25 Fragmentation
  • Increases __________________________ area
  • Increases efficiency of kinetic energy transfer
  • __________________________ projectiles
  • Significant wounding potential
  • Requires high velocity to reliably occur
  • Particularly destructive when combined with concomitant __________________________ wave

26 The Tumble Effect
  • Projectiles travel through a dense __________________________ with their center of gravity forward.
  • __________________________ is an inevitable result of rifle projectile design.

27 Damage Pathway (1 of 2)
  Projectile Injury Process:
  • Tip impacts tissue
  • Tissue pushed __________________________ and to the side
  • Tissue collides with adjacent tissue
    - __________________________ wave of pressure forward and lateral
      -Moves perpendicular to bullet path
  • Rapid __________________________ , crushes and tears tissue
  • Cavity forms __________________________ bullet pulling in debris with suction.

28 Damage Pathway (2 of 2)
  • __________________________ Injury: Damage done as the projectile strikes tissue
  • __________________________ Shock Wave
    - Human tissue is semi-fluid
    - Solid and __________________________ organs are damaged greatly
  • Temporary Cavity: Due to __________________________
  • __________________________ Cavity: Due to seriously damaged tissue
  • Zone of Injury: Area that extends beyond the area of permanent injury

29 Pressure Wave and Cavity

30 Ballistics Cavitation

31 Stippling
  • Deposit of unburned gunpowder in a “ __________________________ ” pattern around the entrance wound
  • Does NOT wipe off
  • Usually indicative of close to __________________________ range
32 **Fouling**
- The concentric deposition of completely burned ____________________________ at the entrance site
- Will wipe off
- Indicative of ____________________________ or close range

33 **Ranges**
- **Close Range:**
  - 6 to 12"
  - Both ____________________________ and ____________________________ are present
- **Intermediate Range:**
  - 12” to 3’
  - No ____________________________; only stippling
- **Long Range:**
  - No fouling or stippling

34 **Specific Weapon Characteristics**

35 **Handguns**
- Handguns;
  - Small caliber, short barrel, ____________________________ -velocity
  - Effective at ____________________________ range
  - Severity of injury based upon ____________________________ damaged
  - Increasing popularity of semi-automatic weapons

36 **Rifles**
- **Hunting Rifles:**
  - ____________________________ -velocity, longer barrel, large caliber
  - Increased accuracy at far distances
- **Assault Rifles:**
  - Large magazine, semi- or ____________________________ -automatic
  - Similar injury to hunting rifles
  - ____________________________ wounds

37 **Shotguns**
- Slug or pellets at ____________________________ velocity
- 00 (1/3”) to #9 (pin head sized)
- Larger the load, the ____________________________ the number of projectiles
- Deadly at ____________________________ range
- Wadding in the wound indicates close range

38 **Knives and Arrows**
- Low-energy & low-__________________________
- Damage related to depth and ____________________________ of attack
- Movement of the victim can ____________________________ damage

39 **The extent of damage is often difficult to assess with wounds caused by low-velocity, low-energy projectiles such as knives and arrows. Suspect ____________________________ hemorrhage and/ or injury to body organs.**
Low-Velocity Wounds

- Objects
  - Knives, Ice-picks, Arrows
  - Flying objects or debris
- Injury limited to tissue impacted
  - Object ____________________________________
  - Object twisting or moved
- Attacker Characteristics
  - ____________________________________ : forward, outward and crosswise
  - ____________________________________ : overhand and downward

Specific Tissue & Organ Injuries (1 of 3)

- ____________________________________ of tissue affects the efficiency of energy transmission
  - Resiliency: Strength and elasticity of an object
- Connective Tissue (muscles, skin, ligaments, etc.)
  - Absorbs energy and ____________________________________ tissue damage

Specific Tissue & Organ Injuries (2 of 3)

Organs:
- Solid Organs: Dense and low resilience
  - Massive ____________________________________
- Hollow Organs
  - Fluid filled: transmit energy = ____________________________________ damage
  - Air filled: absorbs energy = ____________________________________ damage

Specific Tissue & Organ Injuries (3 of 3)

Lungs:
- Air in lung absorbs energy
- Pneumothorax or ____________________________________ can result
Bone:
- Resists displacement until it ____________________________________
  - __________________________ projectile path

General Body Regions (1 of 3)

Extremities
- Injury limited to ____________________________________ of tissue
- 60-80% of injuries with <10% mortality
Abdomen (Includes Pelvis)
- ____________________________________ susceptible to injury and hemorrhage
  - __________________________ perforation: 12-24 hrs peritoneal irritation

General Body Regions (2 of 3)

Thorax:
- Rib impact results in ____________________________________ energy
- Heart & great vessels have extensive damage due to lack of fluid compression
- Any large chest wound compromises __________________________}

General Body Regions (3 of 3)

Neck:
Damages and Blood Vessels
Neurological problems
Sucking wound

Head:
- energy trapped inside skull
- Serious bleeding and lethal

Some 90 percent of penetrating trauma mortality involves the thorax, and abdomen.

Entrance Wound Characteristics
- Size of bullet profile for non-deforming bullets
- Deforming projectiles may cause wounds
- Close Range
  - Burns (Tattooing of powder)
  - 1-2 mm circle of discoloration
  - Localized subcutaneous

Exit Wound Characteristics
- Caused by the passage of the projectile and the
- Appears to be " outward
  - Pressure wave
- ALWAYS check GSW victims for wounds

An wound may more accurately reflect the potential damage caused by a bullet's passage through the body than an entrance wound.

Scene Concerns
Scene Size-Up:
- Law-Enforcement: DO NOT UNTIL SCENE IS SAFE!
- Weapons: Victim or Assailant
- Assailants
- If a crime scene
  - Do not disturb evidence if possible
  - Retain clothing, etc.
  - Limit involvement

Penetrating Wound Assessment
Penetrating Wound Assessment
- Try to determine the of the object and consider damage to organs and vessels in that pathway
- But, remember objects are often or splinter
- Internal Organ Injury Potential
- Entrance & Wounds

PROVIDE TRANSPORT FOR ANY GSW TO HEAD, CHEST, OR ABDOMEN. TREAT AGGRESSIVELY FOR SHOCK!!
Penetrating Wound Care (1 of 3)
Facial Wounds:
- Facial Wounds can make for difficult intubations
- Pass ET through __________________________ chest
- Consider LMA, Combitube, or __________________________ airway
- Consider __________________________ & Cricothyreostomy

Penetrating Wound Care (2 of 3)
Chest Wounds:
- Pneumothorax
  - __________________________ dressing
  - __________________________ Decompression
- Pericardial __________________________

Penetrating Wound Care (3 of 3)
Impaled Objects
- Low-energy
- DO NOT __________________________ ........ UNLESS:
  - In __________________________
  - Interferes with __________________________ : ASSESS!!

Key Points
- Look for __________________________ wounds
- Always __________________________ if GSW is to the trunk
  - You do not know if bullet fragmented or ricocheted
- Regardless of how minor a penetrating injury appears, treat aggressively and
  __________________________ scene time