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 = ___________ \( \times \) 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
- 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.

____________________________________ is the study of the characteristics of projectiles in motion and effects upon objects impacted

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.

16  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

17  Aspects of Ballistics (4 of 6)

Expansion & Fragmentation:
• Results in __________________________ profile
  • __________________________

• Initial impact forces may result in fragmenting
  • Greater __________________________ damage

18  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

19  Aspects of Ballistics (6 of 6)

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

20  Projectile Types

• Simple __________________________

• Semi-jacketed
  - __________________________ point

• Full __________________________

21  Lead Projectiles
- Oldest and ___________________________ to manufacture
- Relatively soft and deformable
- Often ___________________________ upon impact
- Readily ___________________________ the barrel at higher muzzle velocity

22 Semi-Jacketed
- Also referred to as ___________________________ point
  - “Dum-dum”
- Designed to promote ___________________________

23 Full Metal Casing (FMC)
- Prescribed by ___________________________ Convention
- Theoretically creates ___________________________ tissue damage because it resists fragmentation

24 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
• Deposition of gunpowder in a “______________________________” pattern around the entrance wound
• Usually indicative of close range
  – Roughly ________-________ inches
32 Fouling
• The concentric deposition of ____________________________ at the entrance site
• Indicative of ____________________________ or immediate proximity of the weapon
33 Specific Weapon Characteristics
34 Handguns
  Handguns;
  • Small caliber, short barrel, ____________________________ -velocity
  • Effective at ____________________________ range
  • Severity of injury based upon ____________________________ damaged
  • Increasing popularity of semi-automatic weapons
35 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
36 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

37 Knives and Arrows
• Low-energy & low- ___________________________
• Damage related to depth and ___________________________ of attack
• Movement of the victim can ___________________________ damage

38 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.

39 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

40 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

41 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

42 Specific Tissue & Organ Injuries (3 of 3)
Lungs:
• Air in lung absorbs energy
• Pneumothorax or ___________________________ can result
Bone:
• Resists displacement until it ________________ projectile path

43 ⚫ 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

44 ⚫ 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 ____________________________________

45 ⚫ General Body Regions (3 of 3)
Neck:
• Damages ________________________________ and Blood Vessels
• Neurological problems
• Sucking ________________________________ wound
Head:
• ________________________________ energy trapped inside skull
• Serious bleeding and lethal

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

47 ⚫ 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 ________________________________

48 ⚫ Exit Wound Characteristics
• Caused by the passage of the projectile and the ________________________________
• Appears to be “______________________________” outward
  - Pressure wave
• ALWAYS check GSW victims for ________________________________ wounds

49 ⚫ 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
  - ____________________________ chest
  - Pass ET through ____________________________ tissue
  - Consider LMA and ____________________________
  - 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!!!