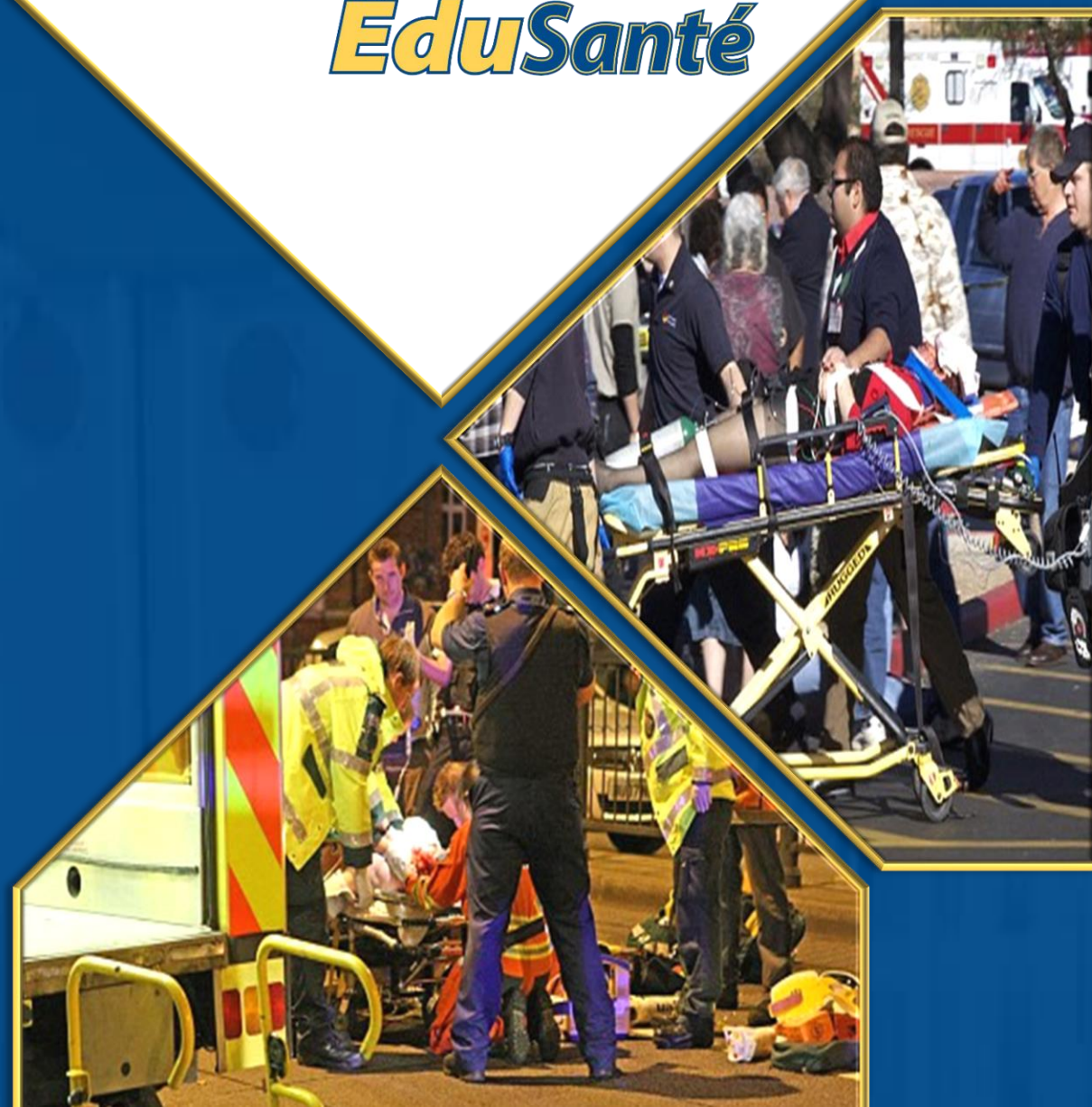
MEDAVIE HealthEd ÉduSanté

Penetrating Trauma

Primary Care Paramedicine



Module: 08

Section: 02b

Lecture Outline

- Introduction
- Physics of penetrating trauma
- Specific tissue/organ injuries
- Special concerns

Introduction

- The number and severity of penetrating traumas increased greatly
- Additional mechanisms
  - Knives
  - Arrows
  - Nails
  - Pieces of glass or wire

Physics

- Recall kinetic energy equation
  - Double the mass, double the energy
  - Double the speed, quadruple the energy
- Explains why small fast bullets have the potential to do great harm
- Wounds from rifle bullets are two to four times more lethal that handguns
  - Heavy bullets travelling very fast

Physics

- Different projectiles of different weights traveling at different speeds cause:
  - Low energy/low velocity
    - Knives and arrows
  - Medium energy/medium velocity weapons
    - Handguns, shotguns, low-powered rifles
  - High energy/high velocity
    - Assault Rifles

Ballistics

- Study of the characteristics of projectiles in motion and effects upon objects impacted
- Aspects of projectile motion
  - Trajectory
  - Energy dissipation

Trajectory

- The path a projectile follows
- Bullets are pulled down by gravity as the travel through the air
  - Causes a curved path
  - The faster the bullet the straighter the path

Factors in Energy Dissipation

- Drag
- Cavitation
- Profile
- Stability
- Expansion
- Shape

MEDAVIE HealthEd ÉduSanté

Weapons

Weapon Characteristics

- Handguns
  - Small caliber, short barrel, medium-velocity
  - Effective at close range
  - Severity of injury based upon organs damaged
- Rifle
  - High-velocity, longer barrel, large caliber
  - Increased accuracy at far distance

Weapon Characteristics

- Assault Rifles
  - Large magazine, semi- or full-automatic
  - Similar injury to hunting rifles
  - Multiple wounds
- Shotgun
  - Slug or pellets at medium velocity
  - Larger the load, the smaller the number of projectiles
  - Deadly at close range

Weapon Characteristics

- Knives and arrows
  - Low-energy and low-velocity
  - Damage related to depth and angle of attack
  - Movement of the victim can increase damage
  - The extent of the damage is often difficult to assess

Projectile Injury Process

- Tip impacts tissue
- Tissue pushed forward and to the side
  - Tissue collides with adjacent tissue
- Shock wave of pressure forward and lateral
  - Moves perpendicular to bullet path
  - Rapid compression, crushes and tears tissue
- Cavity forms behind bullet pulling in debris with suction.

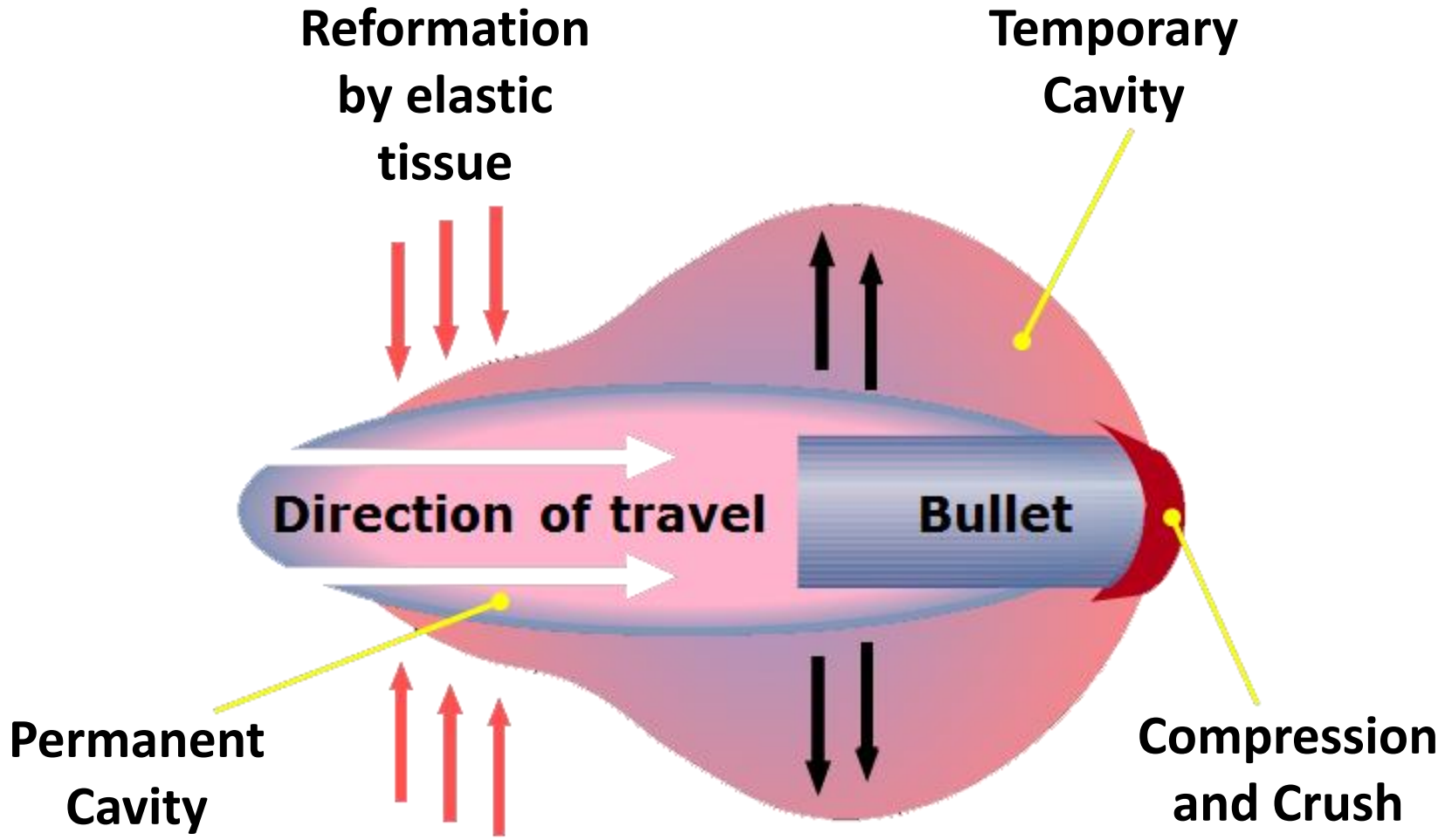
Damage Pathway

- Direct injury
  - Damage done as the projectile strikes tissue
- Pressure shock wave
  - Human tissue is semi-fluid
  - Solid and dense organs are damaged greatly

Damage Pathway

- Temporary cavity
  - Due to cavitation
- Permanent cavity
  - Due to seriously damaged tissue
- Zone of injury
  - Area that extends beyond the area of permanent injury

Cavitation


Reformation by elastic tissue
Temporary Cavity
Direction of travel
Bullet
Permanent Cavity
Compression and Crush

Wounds

- Entry wound
  - Smaller
  - May be darkened, burned
- Exit wound
  - One, none or many
  - Larger
  - May be ragged

Low-Velocity Wounds

- Objects
  - Knives, ice-picks, arrows
  - Flying objects or debris
  - Slow speed limits kinetic energy exchange as the object enters the body
- Injury limited to tissue impacted
  - Object pathway
  - Object may be twisted or moved
  - May be inserted at an oblique angle

Case Study

- 20 y/o male involved in a fight with another male at a bar.

Human Characteristics

- Male attacker
  - Most often strike with forward, outward or crosswise stroke
- Female attacker
  - Strike with an overhand, downward stroke
- Victim
  - Initially attempt to shield themselves with their arms
  - Often receive upper extremity lacerations (defensive wounds)

Injuries to Tissue and Organs

- Extent of damage varies by the particular type of tissue that a projectile encounters
- Density of tissue affects the efficiency of energy transmission
- Resiliency:
  - Strength and elasticity of an object

Connective Tissue

- Dense, elastic and held together very well
- Limited tissue damage
  - Characteristically absorbs energy
  - Wound track closes quickly due to resilience, limiting projectile's pathway

Organs

- Solid organs
  - Have density but not resiliency
  - Tissues compress and stretch in relation to cavitational wave
  - Hemorrhage tends to be severe
- Hollow organs
  - Filled with noncompressable fluid that rapidly transmits energy
  - Energy can tear organ apart explosively
  - Slower, smaller projectiles may produce small holes and create slow leaks

Lungs

- Air in lung absorbs energy
- Parenchyma is compressed and rebounds
- Injury less extensive than with other tissue
- Significant disruption of chest wall integrity may result in pneumothorax or hemothorax

Bone

- Densest, most rigid and nonelastic body tissue
- Resists displacement until it fractures often into numerous pieces
- Significantly alter projectile’s path through the body

General Body Regions

- Extremities
  - Injury limited to resiliency of tissue
  - 60-80% of injuries with <10% mortality
- Abdomen (includes pelvis)
  - Highly susceptible to injury and life-threatening hemorrhage
  - May perforate bowel resulting in irritation and infection

General Body Regions

- Thorax
  - Rib impact results in explosive energy
  - Heart and great vessels have extensive damage due to lack of fluid compression
  - Any large chest wound compromises breathing

General Body Regions

- Neck
  - Traversed by several critical structures
  - Penetrating trauma likely to damage vital structures:
    - Airway compromise
    - Hemorrhage
    - Neurological deficits
  - Associated swelling and hematoma may lead to similar complications

General Body Regions

- Head
  - Skull is a hollow strong and rigid container
  - Brain is a delicate semisolid organ very susceptible to injury
  - If bullet penetrates the skull, cavitational energy trapped, damage extensive
  - Suicide attempts often result in facial trauma as a result of weapon recoil

Entrance Wounds

- Size of bullet profile for non-deforming bullets
- Deforming projectiles may cause large wounds
- Close Range
  - Powder burns (tattooing of powder)
  - 1-2 mm circle of discoloration
  - Localized subcutaneous emphysema

Exit Wounds

- Caused by the physical damage
  - Passage of bullet
  - Cavitational wave
- Blown outward appearance
- May more accurately reflect damage caused by bullet

Scene Assessment

- Ensure that police have secured the scene before you enter it
  - Potential for violence
- Consider the possibility
  - Additional assailants
  - Victim may be armed
- Preserve crime scenes as much as possible
  - Cut around bullet or knife holes and preserve clothing as evidence

Penetrating Wound Assessment

- Determine pathway of object
  - Projectiles do not always travel in straight lines
  - Look for entrance and exit wounds
- Anticipate potential organ injury
- Bullet wounds to head, chest or abdomen
  - Rapid transport
  - Treat aggressively for shock

Facial Wounds

- Gunshot wounds may destroy airway landmarks
- May have to consider more invasive procedures

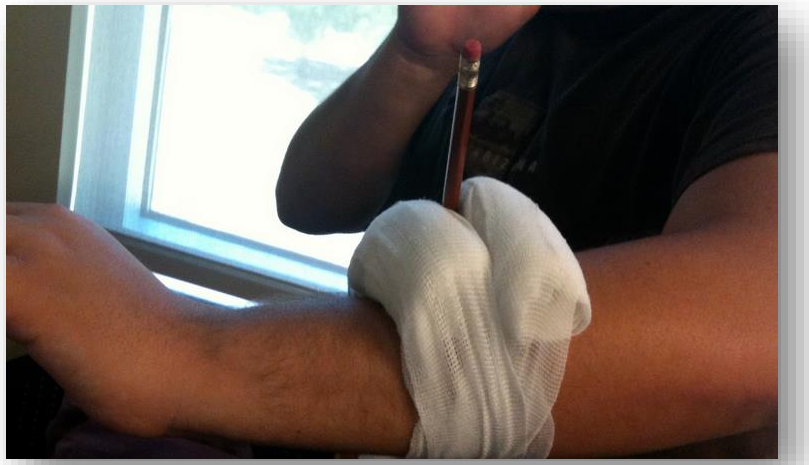
Chest Wounds

- Chest wall is thick and resilient
- Requires a large wound to create opening for air movement
  - Smaller wounds usually result in no air movement
- May have to utilize:
  - Three sided dressing or chest seal
  - Needle decompression
- Consider the possibility of trauma to the heart and great vessels

Chest Wounds

Impaled Objects

- Mainly a low velocity wound, dangerous to remove
  - May cause more damage on exit
  - May be restricting blood loss
- Immobilize as the object is found
- Objects to be removed
  - Lodged in cheek or trachea that interfere with airway
  - Interfering with CPR



Summary

- Physics of penetrating trauma
- Specific tissue/organ injuries
- Special concerns