Mechanism of Injury
Objectives

• At the end of this lecture the participant will be able to:
  – Describe the importance of the mechanism of injury in history taking of the trauma patient.
  – Identify patterns of injury from the type of mechanism deployed to the patient.
  – Discuss the importance of injury prevention as part of the continuum of trauma care.
Epidemiology

- Trauma: Defined as injury to human tissues and organs resulting from the transfer of energy from the environment
- Motor vehicle crash (MVC) instead of motor vehicle accident (MVA)
Incidence - United States

• Incidence
  - 4th leading cause of death for all ages
  - 1st leading cause of death for ages 1 to 44 years

• Causes
  - Motor vehicle crashes
  - Suicide
  - Homicide and legal intervention
  - Other
Human Characteristics -

- Age
- Gender
- Race
- Alcohol
- Violence
Injury Prevention and Control

• Focuses on reducing the incidence of injury events
• Injury control strategies are classified as the following interventions:
  - Engineering and technologic
  - Enforcement and legislative
  - Education and behavioral
Injury Prevention and Control

• Recommendations for injury prevention
  - Enhance injury surveillance systems
  - Enhance research of biomechanics and pathophysiology and reparative processes
  - Develop national policy
  - Authorize the Health Resources and Services Administration to fund trauma care systems
Biomechanics and Mechanism of Injury

- Biomechanics: The study of the principles of the action of forces and their effects
- Kinematics: A branch of mechanics (energy transfer) referring to motion
- Mechanism of Injury (MOI): The mechanism whereby energy is transferred from the environment to the person
Energy Sources and Mechanism of Injury
Mechanical Energy

- Epithelial tissue: Skin, trachea, mucous membranes
- Connective tissue: Cartilage, bone, joint structures
- Muscle tissue: Cardiac, skeletal, blood vessels
- Nerve tissue: Neurons and supporting cells
External Forces

- Mechanical energy
  - Deceleration
  - Acceleration
  - Combination forces
  - Other forces

- Contributors to the amount of energy a moving object has:
  - Mass
  - Velocity (greatest influence)
Deceleration Forces

• Relative fixation of certain structures predisposes them to deceleration injuries

• Differences in the rate of deceleration of specific body parts
  - Aorta, near ligamentum arteriosum
  - Retroperitoneal duodenum, near ligament of Treitz
Acceleration Forces

Acceleration Examples

• When a stationary or slow moving pedestrian is struck by a car

OR

• When an occupant of a slow moving car is struck from the rear by another fast moving car
Other Forces

- Amount of energy is dependent upon the velocity at which the object strikes the victim and the object’s mass
- Blunt or penetrating forces
  - Bullets
  - Fists
  - Stabbing instruments
  - Blasts or explosions
Internal Forces

- **Stress**: Forces applied to deform the body or the equal and opposite forces with which the body resists
  - Tensile stress
  - Compressive stress
  - Shearing stress

- **Strain**: Tissue damage or deformation that results from the stress
Types of Injuries

- **Blunt**
  - Motor vehicle crashes
  - Motorcycle crashes
  - Falls
- **Penetrating**
  - Stab wounds
  - Firearm injuries
Gunshot Wounds (GSW)

- **Firearm**: Any weapon capable of firing a projectile and using an explosive charge as a propellant.
- **Ballistics**: In medicine, the study of wounding the body by a projectile.
- **Biomechanics of tissue damage**: is based on the kinetic energy of the projectile and the density and elasticity of the tissue.
GSW - Ballistics

- Wound profile: the permanent and temporary cavities the projectile produces.
- Internal ballistics refers to motion within the weapon: caliber, muzzle velocity, rifling, barrel length, cartridge.
- External ballistics refers to motion of the projectile in the air: yaw, tumbling
GSW - Ballistics

- Terminal ballistics refers to motion and effect of a projectile on striking a solid or liquid.
- Projectiles dissipate a tremendous amount of kinetic energy (KE) to the tissues through which they pass and is responsible for most of the damage.
- Increasing the velocity of a projectile has a much greater effect on KE than increasing its mass.
In general, the greater the density of the tissue, the more energy transferred.

Permanent cavity: Crushed tissue of the hole or tract caused by the projectile as it moves through the tissue.

Temporary cavity: The blast effect caused by the tissues stretching as the KE is being absorbed by them.
GSW - Shotgun
GSW - Shotgun
Stab Wounds

- **Stab/Impalement** - wound size and history about the type of weapon used does not correlate to depth of wound or wound trajectory because the victim’s or witnesses’ perceptions may not be accurate.

- An impaled weapon should not be removed except in the operating room.

- 4% mortality rate is primarily from direct injuries to great vessels or the heart.
Stab vs Impalement Wounds
Impalement

• Usually occurs secondary to a fall onto a piercing object or sustained from machinery or pneumatic tools, but also includes low velocity non-firearm projectiles such as arrows.
Impalement

- 28 y/o male, MCC, fell into a pile of wood.
- This piece of wood entered chest behind sternum, anterior to heart. Perforated the diaphragm and passed between the liver and spleen.
Impalement

• Drag racer lost control of the car and struck a chainlink fence while traveling backwards.

• Top rail of the fence entered the rear of the car impaling the driver’s pelvis.

• Only sustained gluteal muscle tears.
Impalement

- An impaled object should be removed only in the operating room under direct vision and after a thorough dissection of the wound tract.
- The wound can be complicated by blunt dissection from the fall, secondary injuries from extraction by untrained personnel or unintentional shifts of the object during transport.
Stab/Impalment Wounds

- Necrotizing fasciitis resulted from a missed rectal injury.
- Initial injury was a stab wound in the buttocks 48 hours before.
- Patient died in the OR.
Impalement

• Crossbows - usually unable to pass through weight bearing bone, but easily penetrates ribs, sternum, calvarium. Should be treated as an impalement.

• Arrows - wound depends on weight and velocity of arrow and type of tip (hunting vs. target).
Forensics

• Because medical records are legal documents that can be subpoenaed by courts, all wounds must be described in a precise and accurate manner and evidence preserved.

• Wound sizes should be measured, not estimated and positions related to anatomical landmarks.
Patterns of Injury

- Age
- Mechanism of injury
- Anatomic structures involved
- Pre-existing factors

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Patterns of Injury

• **Possible injuries when a pedestrian is struck by a motor vehicle**
  - Knees, tibia, fibula, femur, pelvis
  - Vertebral column injury

• **Possible injuries for a motorcyclist**
  - Face, chest, lower legs
  - Cranial and cervical injuries
Falls and Jumps

- Axial loading: Falling or jumping from a height
- Energy is applied to the axial skeleton
- Pattern of injury related to falls or jumps from heights is a consequence of several factors
Vehicular Occupant Protection

- Occupant protection technology
- Restraint systems
- Air bags: Controversial
Air Bags

National Highway Traffic Safety Administration (NHTSA) guidelines

• Driver’s seat should be “rearward,” tilted back; distance from the sternum at least 10”
• Wear a lap/shoulder belt
• Children 12 years and younger should ride in the back seat
• Rear-facing child restraints should NEVER be used in a seat with an air bag
Summary

1 PHASES OF INJURY

**MECHANISMS OF INJURY**
Vehicle of transfer of energy from environment to human host

**EXAMPLES**
- Falls
- Motor Vehicle Crashes
- Bullets
- Stabbing Instruments
- Blasts/Bombs

2 EXTERNAL FORCES

**DECELERATION FORCES**
Decrease in speed of a moving object or person

**ACCELERATION FORCES**
Increase in speed of a moving object or person

**BLAST FORCES**
Heat, light, pressure

**LOW AND HIGH VELOCITY MISSILES**

3 INTERNAL FORCES

**HUMAN BODY'S RESPONSE TO KINETIC ENERGY LOAD**

**STRESS**
- Cells separate, stretch, compress, or shear

**STRAIN**
- Tissue damage or deformation from stress

4 TYPES OF INJURIES

**DESCRIPTION FOR CLINICAL AND DIAGNOSTIC PURPOSES**

**BLUNT VS PENETRATING**
Closed vs Open
Primary vs Secondary
Direct vs Indirect