

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**

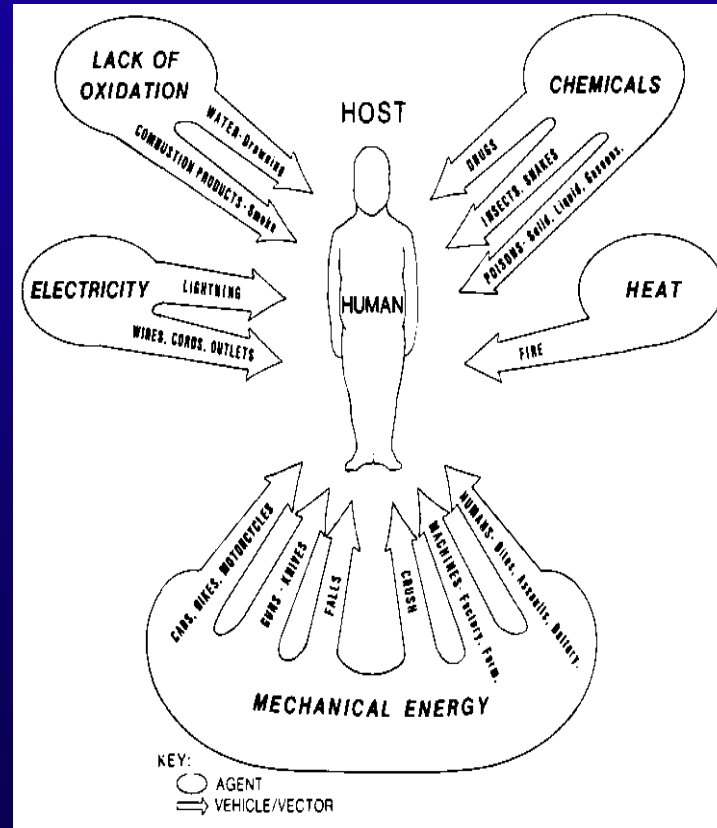
Injury Prevention and Control

- **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

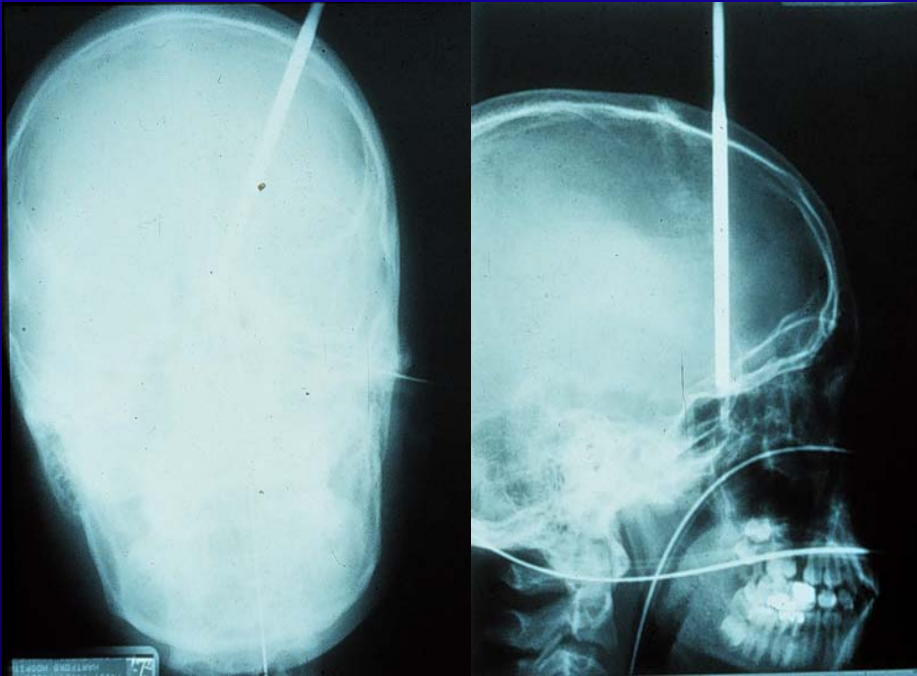
- Amount of energy is dependent upon the velocity at which the object strikes the victim and the object's mass
- Blunt or penetrating forces
 - Bullets
 - Fists
 - Stabbing instruments
 - Blasts or explosions



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.

GSW - Tissue Characteristics

- 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.

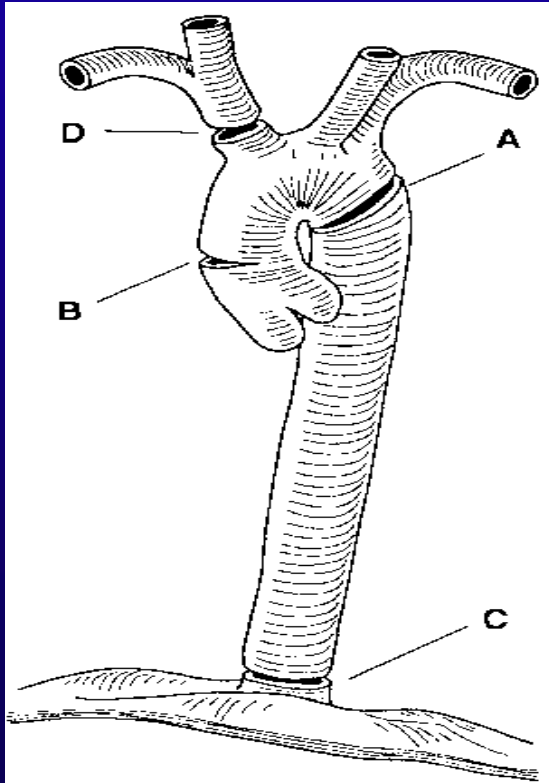
Impalement

- **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



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

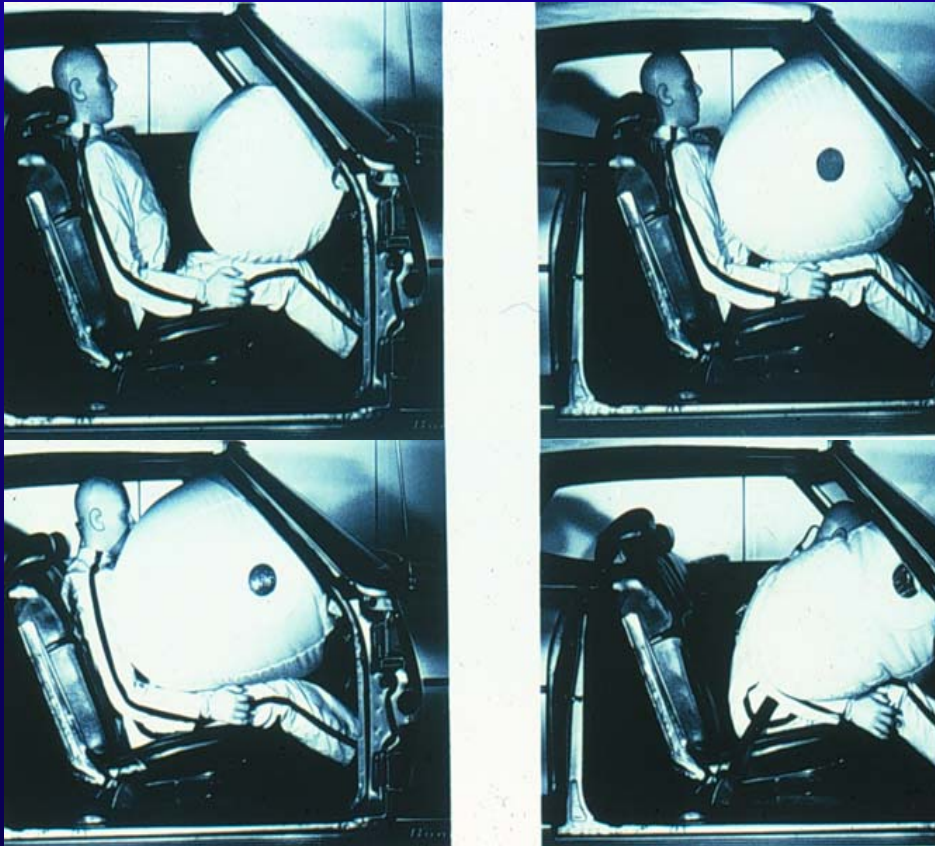
Patterns of Injury

- **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

- Victim strikes
steering column
- Victim impacts
ground

ACCELERATION FORCES
Increase in speed
of a moving object
or person

- Pedestrian thrown
when struck by
moving vehicle

BLAST FORCES
Heat, light, pressure

- Bomb explosion

**LOW AND HIGH VELOCITY
MISSILES**

- Bullets
- Stabbing instruments

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