Mechanisms of Injury

Ahmed Alburakan, MD, MSc ,FRCSC , FRCPC

Assistant professor & consultant

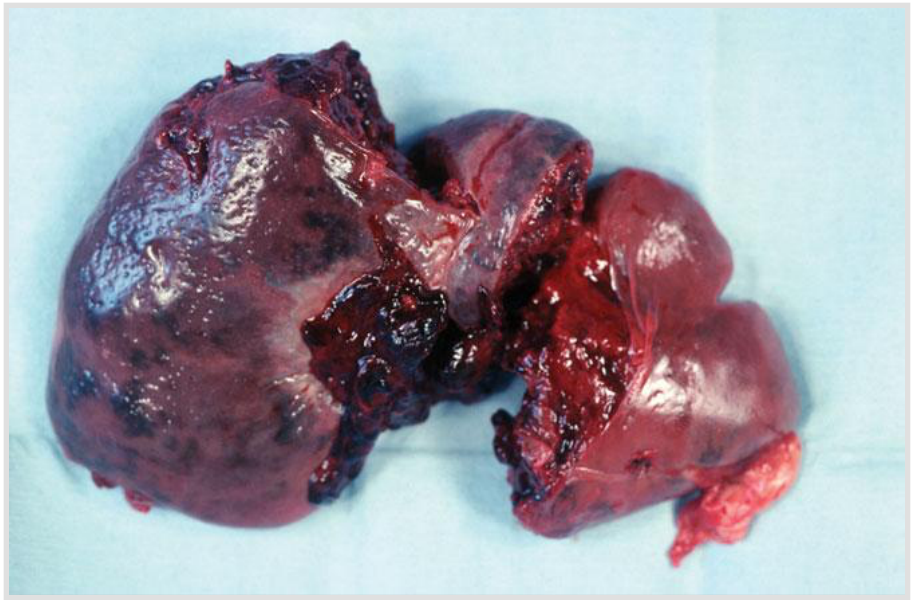
King Saud University

Introduction

- Trauma is the primary cause of death and disability between ages 1 to 44 years.
- Analyzing a trauma scene is a vital skill.
- Determining the events that lead to trauma, often predict the injuries encountered.

Trauma

- Injury occurs when an external source of energy affects the body beyond its ability to sustain and dissipate energy.



© Shout Pictures

Trauma

- Different forms of energy produce different kinds of trauma.
  - Mechanical energy
  - Chemical energy
  - Electrical energy
  - Barometric energy

Factors Affecting Types of Injury

- Ability of body to disperse energy delivered
- Force and energy
  - Size of object
  - Velocity
  - Acceleration or deceleration
  - Affected body area
- Duration and direction
  - The larger the area, the more energy will be dissipated.
- Position of victim

Factors Affecting Types of Injury

- The impact resistance of body parts has a bearing on types of tissue disruption.
  - Organs that have gas inside are easily compressed.
  - Liquid-containing organs are less compressible.

Blunt Trauma

- Injuries in which tissues are not penetrated by external object

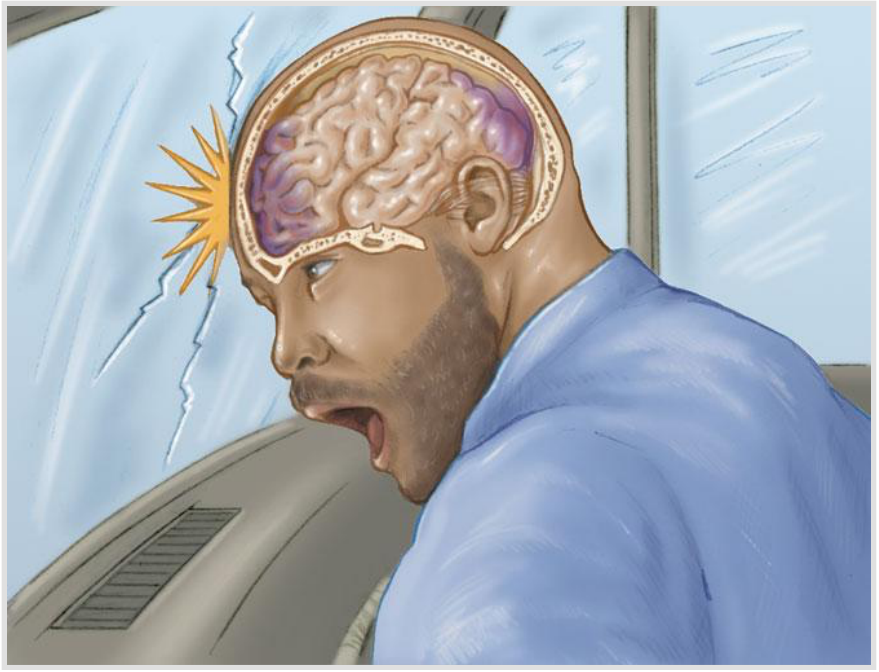
Motor Vehicle Crashes

- Five phases of trauma:
  - Phase 1: Vehicle Deceleration
  - Phase 2: Occupant deceleration

Courtesy of Captain David Jackson, Saginaw Township Fire Department

Motor Vehicle Crashes

- Five phases of trauma (cont'd):
  - Phase 3: Deceleration of internal organs
  - Phase 4: Secondary collisions
  - Phase 5: Additional impacts received by the vehicle

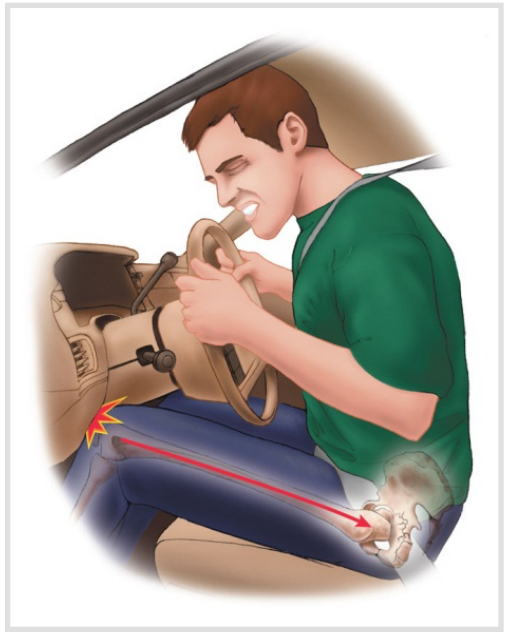


Impact Patterns

- **Frontal or head-on impacts**
  - Front end of the car distorts.
  - Passengers decelerate at same rate as vehicle.
  - Abrupt deceleration injuries are produced by a sudden stop of a body's forward motion.

Impact Patterns

- Frontal or head-on impacts (cont'd)
  - Unrestrained occupants usually follow one of two trajectories:
    - Down-and-under pathway
    - Up-and-over pathway



Impact Patterns

- Lateral or side impacts
  - Impart energy to the near-side occupant
  - Seat belts offer little protection.
  - The body is pushed in one direction, while the head moves toward the impacting object.

© Alexander Gordeyev/ShutterStock, Inc.

Impact Patterns

- Rear impacts
  - Have the most survivors
  - Whiplash injury is common.
  - Energy is imparted to the front vehicle.

© Dennis Wetherhold, Jr

Impact Patterns

- Rotational or quarter-panel impacts
  - Occurs when a lateral crash is off center
  - The vehicle's forward motion stops, but the side continues in rotational motion.

Impact Patterns

- Rollovers
  - Patients may be ejected.
  - Patients may be struck hard against the interior of the vehicle.

© iStockphoto/Thinkstock

Restrained Versus Unrestrained Occupants

- Seat belts stop the motion of an occupant traveling at the same speed as the vehicle.
  - Associated injuries include cervical fractures and neck sprains.

Restrained Versus Unrestrained Occupants

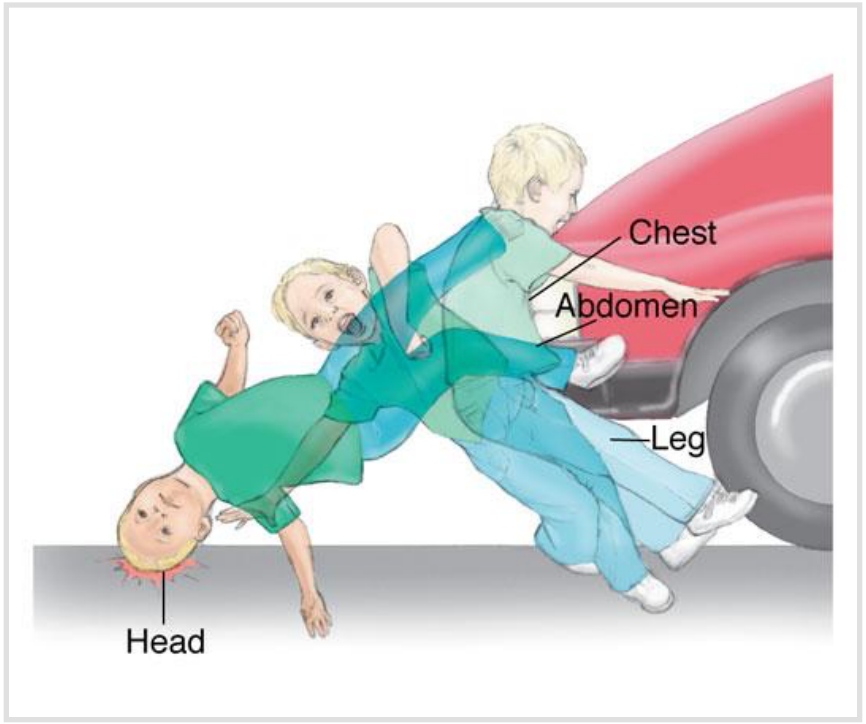
- Air bags have reportedly reduced deaths in direct frontal crashes by about 30%.
  - Can also result in secondary injuries:
    - Direct contact
    - Chemicals

Pedestrian Injuries

- Three predominant MOIs:
  - First impact:
    - Car strikes body with its bumpers.
  - Second impact:
    - Adult is thrown on hood and/or grille of vehicle.
  - Third impact:
    - Body strikes the ground or some other object.

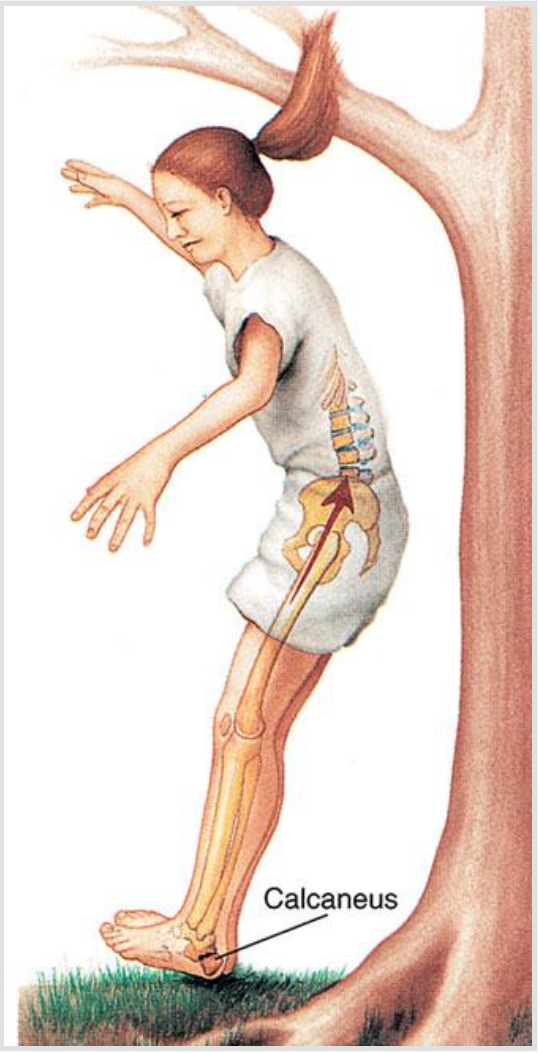
Pedestrian Injuries

- **Waddell triad**: Pattern of injuries in children and people of short stature
  - Bumper hits pelvis and femur.
  - Chest and abdomen hit grille.
  - Head strikes vehicle and ground.



Falls from Heights

- Severity of injuries impacted by:
  - Height
  - Position
  - Surface
  - Physical condition



Penetrating Trauma

- Involves disruption of skin and tissues in a focused area
  - Low velocity: Caused by sharp edges
  - Medium and high velocity: Object might flatten out, tumble, or ricochet.

Stab Wounds

- Severity depends on:
  - Anatomic area involved
  - Depth of penetration
  - Blade length
  - Angle of penetration

Gunshot Wounds

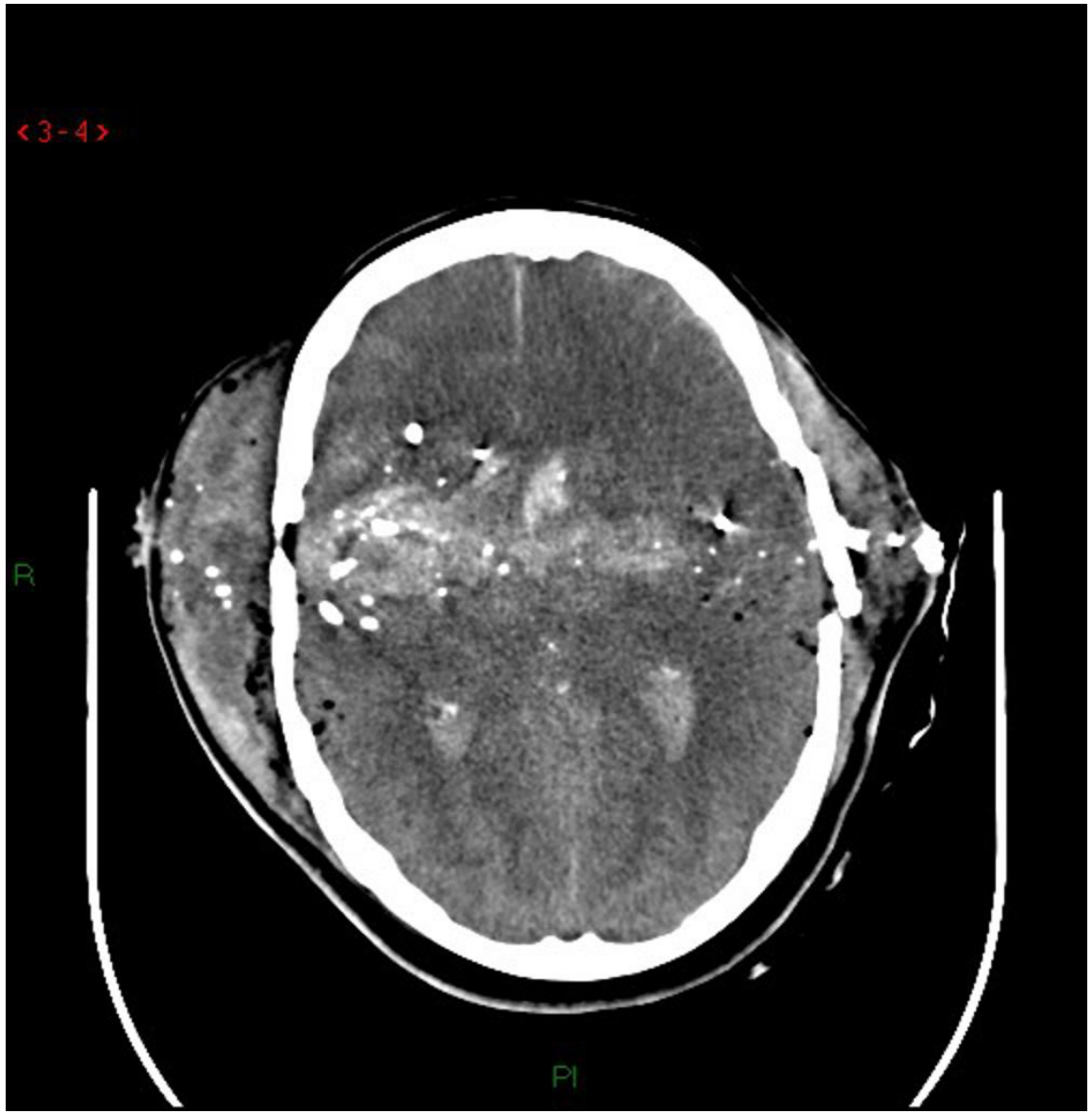
- Severity depends on:
  - Type of firearm
  - Velocity of projectile
  - Physical design/size of projectile
  - Distance of victim from muzzle
  - Type of tissue struck

Gunshot Wounds

- Handgun
  - Revolver holds 6 to 10 rounds of ammunition
  - Pistol holds up to 17 rounds of ammunition
  - Accuracy is limited.
- Shotguns
  - Fire round pellets
- Rifles
  - Fire single projectile at a very high velocity
  - Impart a spin for accuracy

Gunshot Wounds

- Projectile creates a permanent cavity.
  - May be straight line or irregular pathway
  - Pathway expansion: Tissue displacement that results from low-displacement sonic pressure
  - Missile fragmentation: Projectile sends off fragments that create paths through tissues.



Gunshot Wounds

- Exit wounds occur when projectile's energy is not entirely dissipated.
  - Size depends on energy dissipated and degree of cavitation.

Entrance wound

© Chuck Stewart, MD

D.Willoughby/Custom Medical Stock Photography

Exit wound

Gunshot Wounds

- Wounding potential depends on:
  - Powder charge
  - Size and number of pellets
  - Dispersion of the pellets
    - Range at which the weapon was fired
    - Barrel length
    - Type of choke at the end of the barrel

Gunshot Wounds

- Try to obtain the following:
  - Weapon used
  - Range fired
  - Bullet used
- Look for:
  - Powder residue around the wound
  - Entrance and exit wounds

Trauma Care

Goals/ Principles of Trauma Care

- Rapid, accurate, and physiologic assessment
- Resuscitate, stabilize, and monitor by priority
- Prepare for transfer to definitive care
- Teamwork for optimal, safe patient care

Principles

- Treat greatest threat to life first
- Definitive diagnosis less important
- Physiologic approach
- Time is of the essence
- Do no further harm
- Teamwork required to succeed

Approach

Airway with c-spine protection

Breathing/ ventilation/ oxygenation

Circulation: Stop the bleeding!

Disability (neuro status)

Expose/ Environment/ body temp

Sequence and Teamwork

- Simultaneous primary survey and resuscitation of vital functions
- Simultaneous secondary survey and reevaluation of vital functions

In-hospital Preparation

- Preplanning essential
- Team approach
- Trained personnel
- Proper equipment
- Lab / x-ray capabilities
- Standard precautions
- Transfer agreements
- QI Program

Standard Precautions

- Cap
- Gown
- Gloves
- Mask
- Shoe covers
- Goggles/ face shield

Triage

- Sorting of patients according to
  - ABCDE's
  - Available resources
  - Other factors, e.g., salvageability

Primary Survey

Priorities are the same for all!

Primary Survey

A Airway / C-spine protection

B Breathing / Life-threatening chest injury

C Circulation / Stop the bleeding

D Disability / Intracranial mass lesion

E Exposure / Environment/ Body temp

Primary Survey: Airway

- Assess for airway patency
- Snoring
- Gurgling
- Stridor
- Rocking chest wall motions
- Maxillofacial trauma/ laryngeal injury

C-Spine Injury

Resuscitation: Patent Airway

- Chin lift/ Modified jaw thrust
- Look, listen, feel
- Remove particulate matter
- Definitive airway as necessary
- Reassess frequently

C-Spine Injury

Resuscitation: Assess Breathing

- Chest rise and symmetry
- Air entry
- Rate/ Effort
- Color/ Sensorium

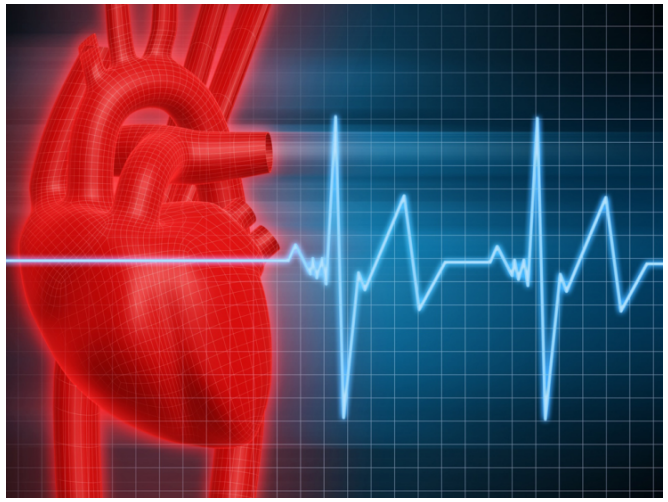
Tension / open pneumothorax

Resuscitation: Breathing

- Administer supplemental oxygen
- Ventilate as needed
- Tension pneumothorax: Needle decompression
- Open pneumothorax: Occlusive dressing
- Reassess frequently

Primary Survey: Circulation

- Non hemorrhagic shock
  - Cardiac tamponade
  - Tension pneumothorax
  - Neurogenic
  - Septic (late)



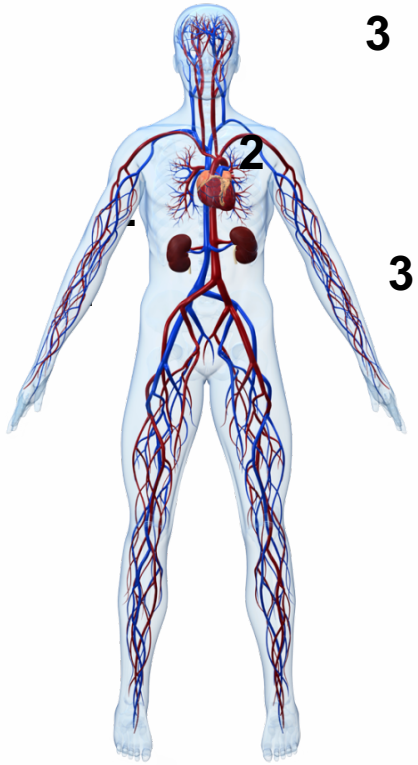
Primary Survey: Circulation

- Assess organ perfusion
  - Level of consciousness
  - Skin color
  - Pulse rate and character

Primary Survey: Circulation

Assess Organ Perfusion

1. Tachycardia
2. Vasoconstriction
2. ↓ Cardiac output
2. Narrow pulse pressure
3. ↓ MAP
3. ↓ Blood flow



Resuscitation: Circulation

Bleeding?

Find it!

- Direct pressure
- Operation
- Avoid blind clamping

Resuscitation: Circulation

- Obtain venous access
- Restore circulating volume
  - Ringer's lactate, 1-2 L
  - PRBCs if transient response or no response
- Reassess frequently

Resuscitation: Circulation

Consider

- Tension pneumothorax: Needle decompression and tube thoracostomy
- Massive hemothorax: Volume resuscitation and tube thoracostomy
- Cardiac tamponade: Pericardiocentesis and direct operative repair

Primary Survey: Disability

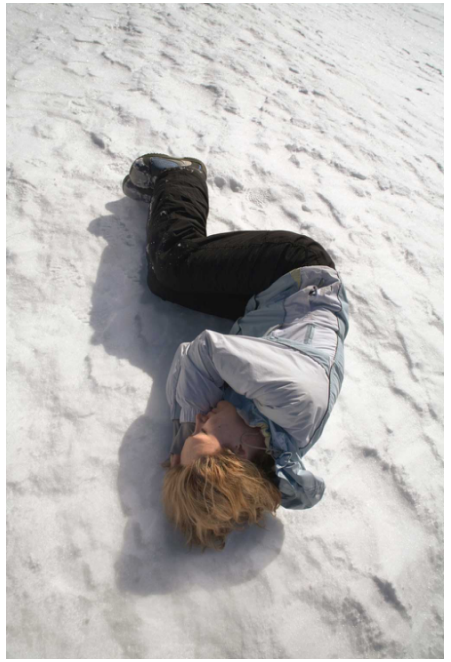
- Baseline neurologic evaluation
  - Pupillary response
  - Neurosurgical consult as indicated

Observe for neurologic deterioration

Primary Survey: Exposure

- Completely undress the patient
- Remove helmet if present
- Look for visible / palpable injuries
- Log roll, protect spine

Prevent hypothermia



Resuscitation: Overview

- If in doubt, establish definitive airway
- Oxygen for all trauma patients
- Chest tube may be definitive for chest injury
- Stop the bleeding!
- 2 large-caliber IVs
- Prevent hypothermia

Primary Survey: Adjuncts

Monitoring

- Vital signs
- ABGs
- ECG
- Pulse oximetry
- End-tidal CO_2

Diagnostic Tools

- Chest / pelvis x-ray
- C-spine x-rays when appropriate
- FAST
- DPL

Consider need for transfer

Secondary Survey: Start After

- Primary survey completed
- Resuscitation in process
- ABCDEs reassessed
- Vital functions returning to normal

Secondary Survey: Key Parts

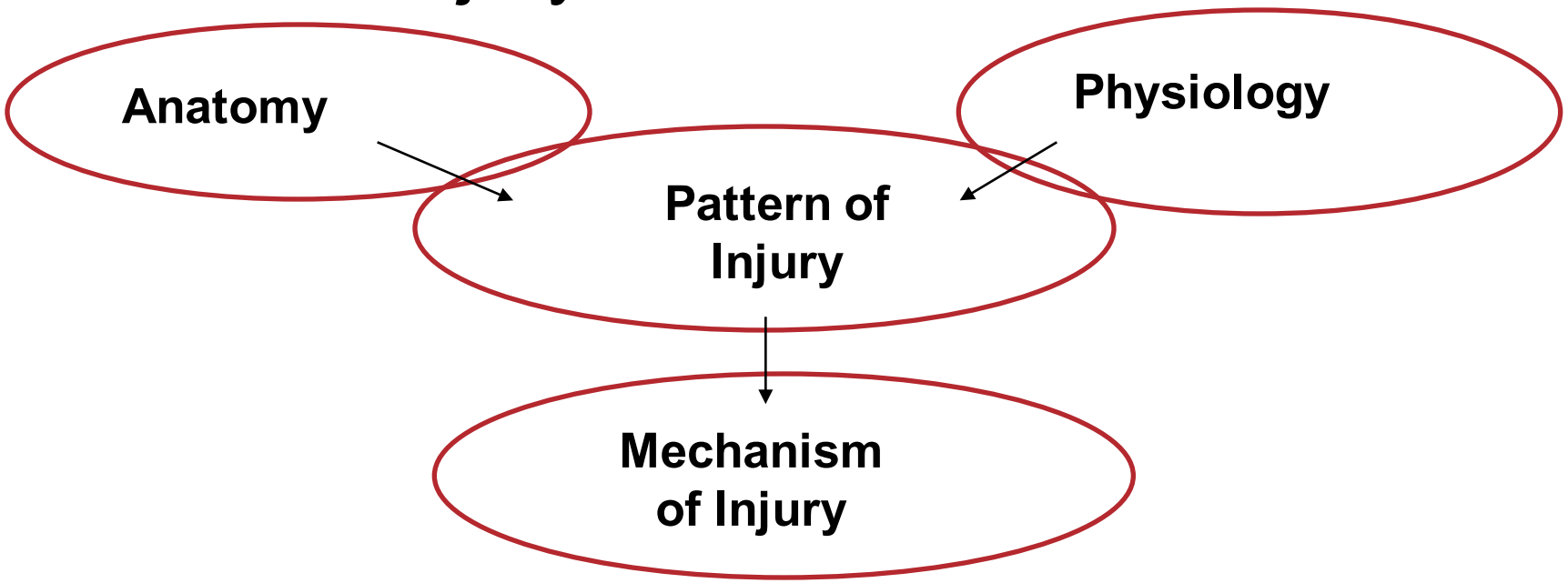
- AMPLE History
- Complete physical exam: Head-to-toe
- Complete neurologic exam
- Special diagnostic tests
- Reevaluation

Secondary Survey: History

A	Allergies
M	Medications
P	Past illnesses / Pregnancy
L	Last meal
E	Events / Environment

Secondary Survey

Mechanism of Injury



Summary

Definitive care

Safe transfer

Continuous Reevaluation

Primary Survey Adjuncts

Resuscitation

Secondary Survey Adjuncts

Summary

- One, safe way
- Do no further harm
- Treat greatest threat to life first
- Teamwork

Thank You