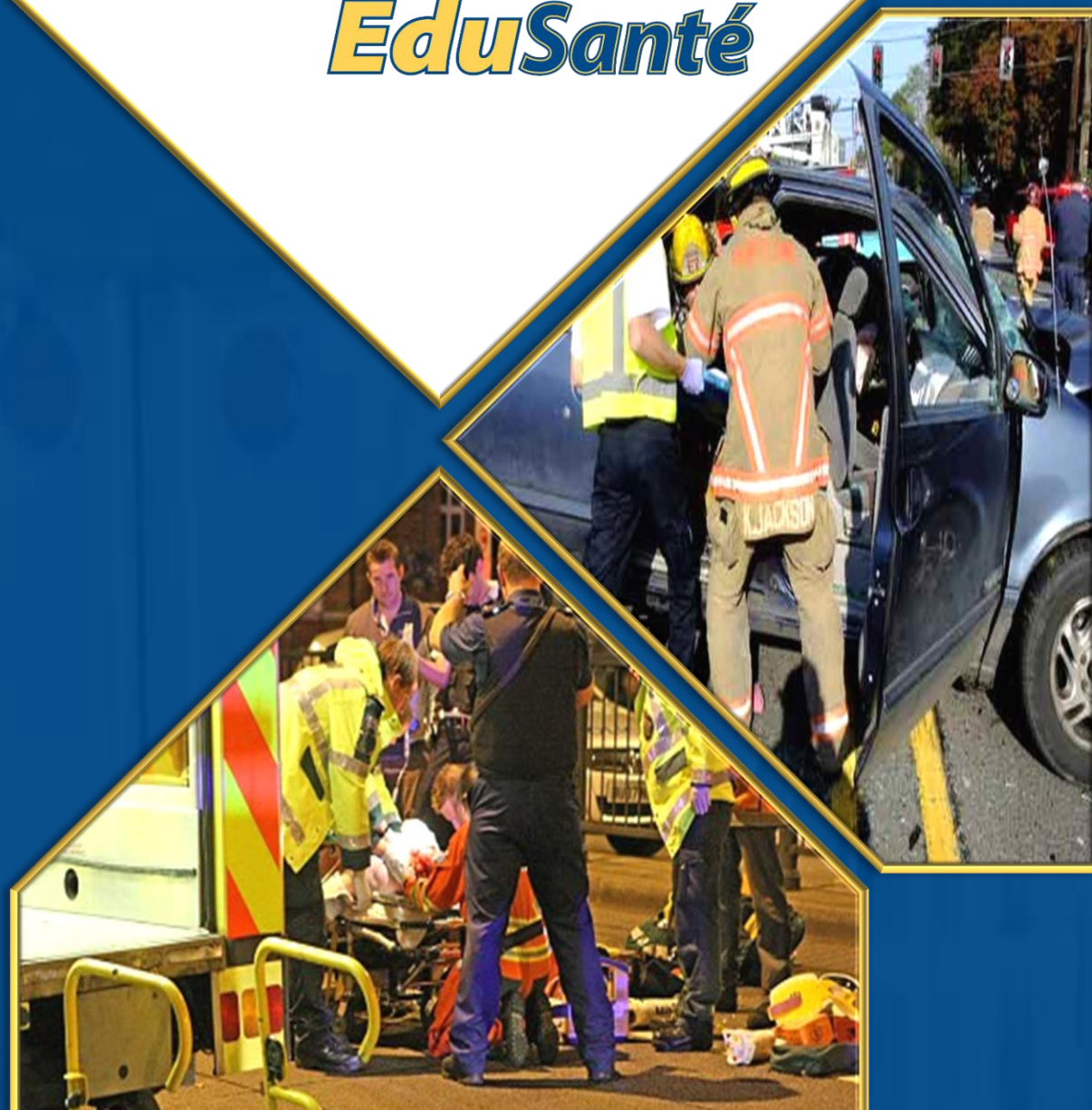
MEDAVIE HealthEd ÉduSanté

Blunt Trauma

Primary Care Paramedicine



Module: 08

Section: 02a

Lecture Outline

- Introduction
- Blunt Trauma
  - Automobile collisions
  - Blasts
  - Other blunt trauma

Introduction to Blunt Trauma

- Most common cause of trauma death and disability
- Energy exchange between an object and the human body, without intrusion through the skin
- Can be deceptive
  - The true nature of the injury is often hidden
  - Evidence of the serious injury may be very subtle or even absent

Blunt Trauma

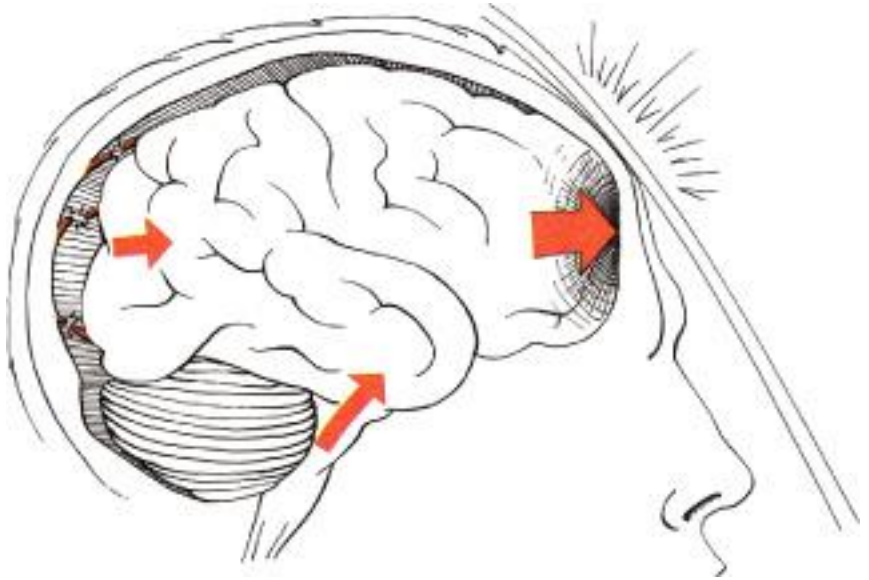
- Most commonly from motor vehicle collisions
  - Automobiles
  - Motorcycles
  - Pedestrians
  - Recreational vehicles
  - Explosions
  - Falls
  - Crush injuries
  - Sporting injuries

Deceleration Injuries

- After impact organs continue to pull against structures that attach them to the body
  - Organs may separate from attachments
  - Vascular pedicle or mesenteric attachment injury may cause hemorrhage

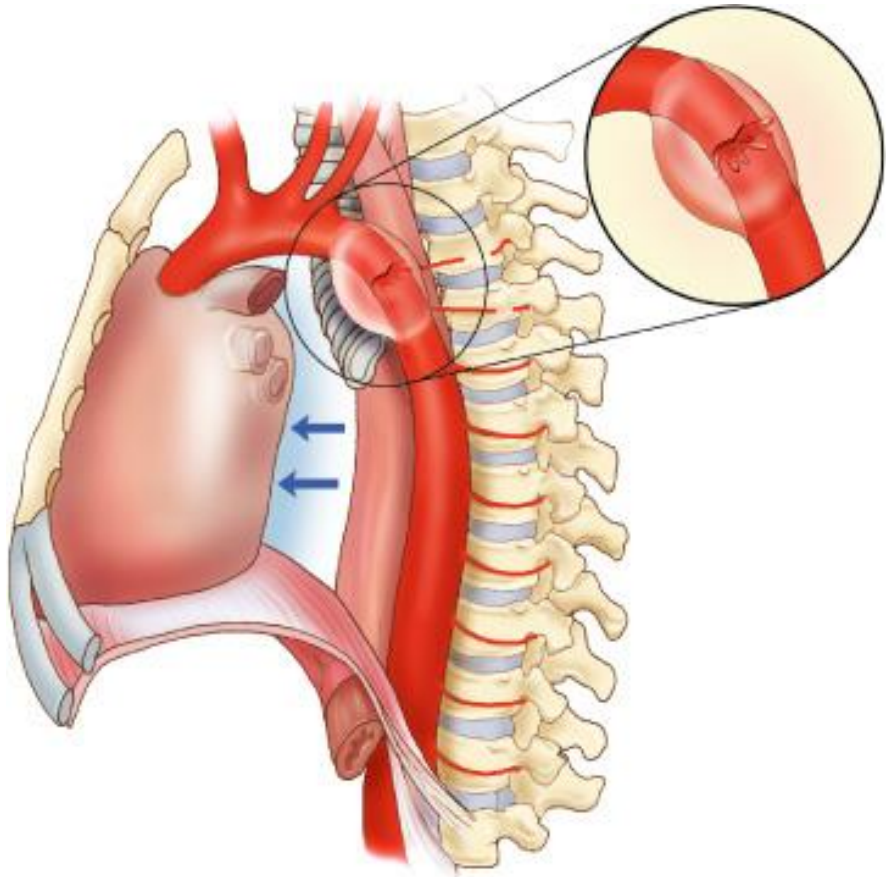
Head Injuries

- Head strikes stationary object
- Cranium stops abruptly
- Brain continues moving and is compressed against skull



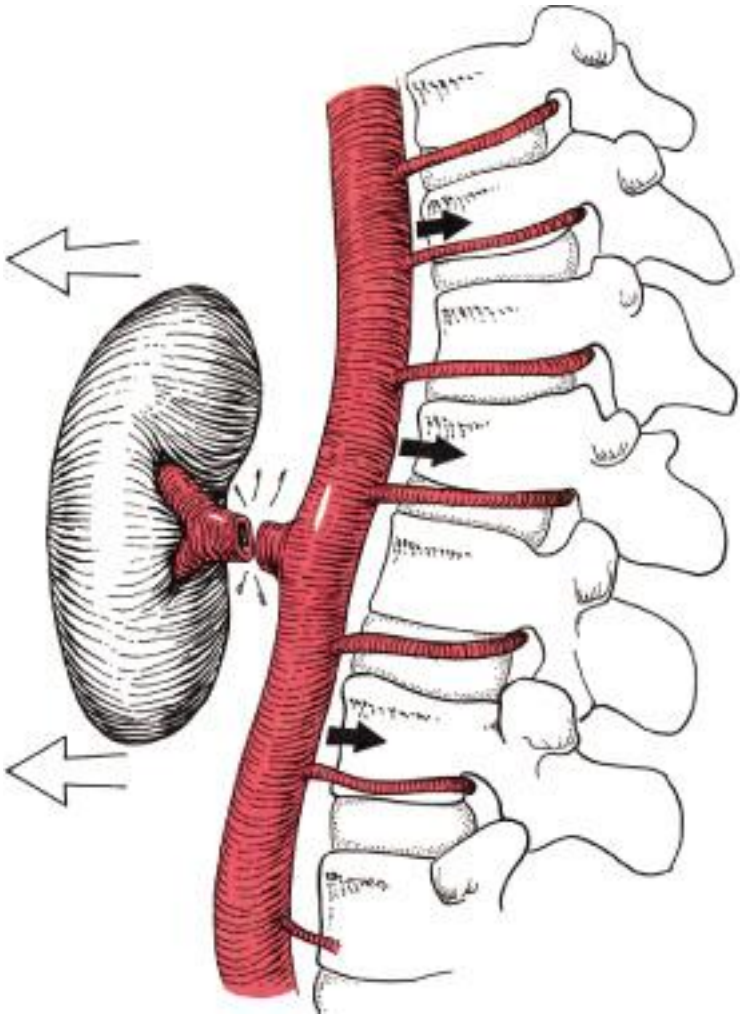
Thoracic Injuries

- Aorta often injured by severe deceleration forces
  - Usually sheared at ligamentum arteriosum attachment
- Rupture causes rapid exsanguination



Abdominal Injuries

- Abdominal organs and retroperitoneal structures (most commonly the kidneys) may be affected by deceleration forces



Crush Injuries

- Causes
  - Structural collapse, explosion, industrial or agricultural
- Pathophysiology
  - Tissue stretching and compression
  - Extended pressure results in anaerobic metabolism distal to compression
  - Return of blood flow, toxins to entire body
  - Severe hemorrhage due to severe damaged blood vessels

Mechanical Principle

- Severity and pattern depend on:
  - Direction of impact
  - For vehicle crashes—energy absorbed by vehicle
  - Part(s) of body to which energy is transmitted
  - Use of protective equipment
  - Compression, deceleration, acceleration
  - Density and contact area of object
  - Velocity at impact

Mechanical Principle

- Again, a crash is any impact between the body and an object
- Assessment and management of the injured patient must consider three phases:
  - Pre-crash
  - Crash
  - Post-crash

Pre-crash

- Pre-crash factors must be considered in the assessment and management of the trauma patient:
  - Patient age and size
  - Drugs/alcohol
  - Preexisting medical conditions and
  - Medications

Crash

- The crash phase begins at the moment of initial impact
- Remember, there are at least three impacts in most collisions
- Our understanding of Newtonian physics help

Post-crash

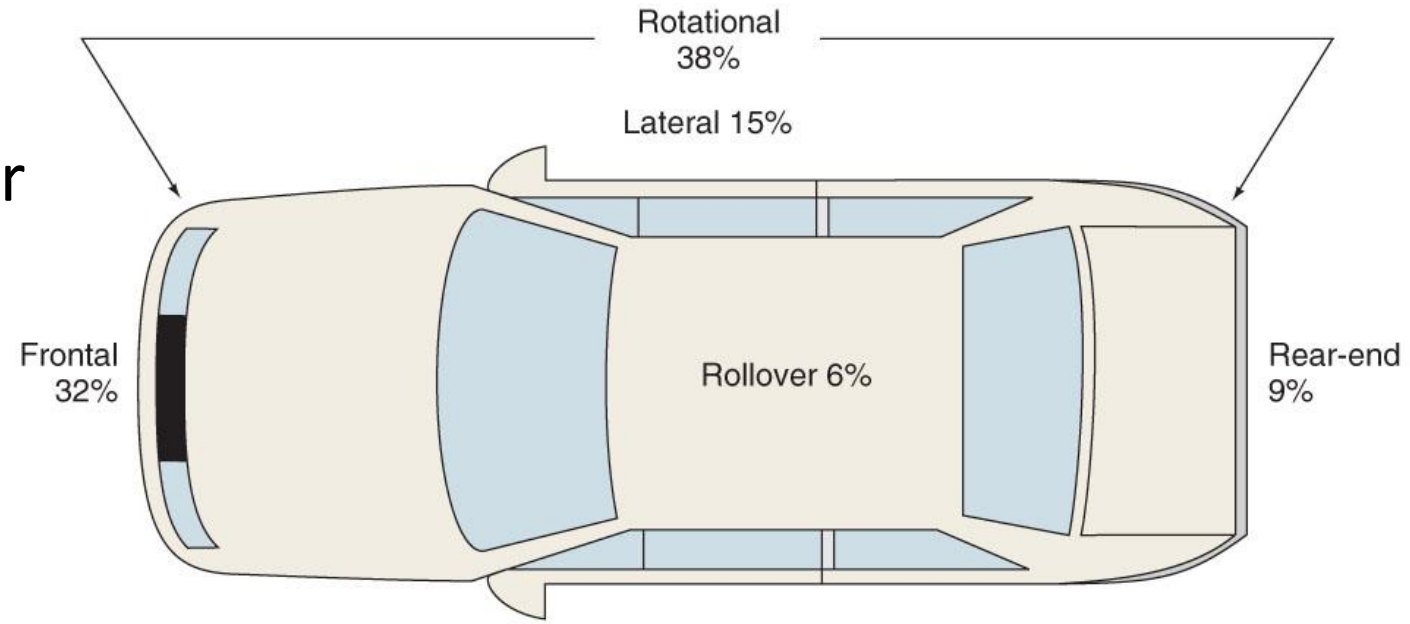
- Post-crash
  - Patient outcome is affected by conditions after the crash
    - Response time and resources available
    - Providers' knowledge of kinematics, assessment and management
  - Providers' response depends on knowledge of energy and anatomy

Types of Impact

- Motor vehicle crashes come in many varieties:
  - Frontal impact
  - Rear impact
  - Lateral impact
  - Rotational impact
  - Rollover
  - Motorcycle crashes
  - Pedestrian–motor vehicle crashes

Types of Impact

- Frontal: 32%
- Lateral: 15%
- Rotational: 38%
  - Left & Right – Front & Rear
- Rear-end: 9%
- Rollover: 6%



Blunt Trauma

FRONTAL IMPACT

Frontal Impacts

- Most common type of impact
- Often result in significant exchange of energy and serious injuries
- Produces three pathways of occupant travel
  - Down and under pathway
  - Up and over pathway
  - Ejection

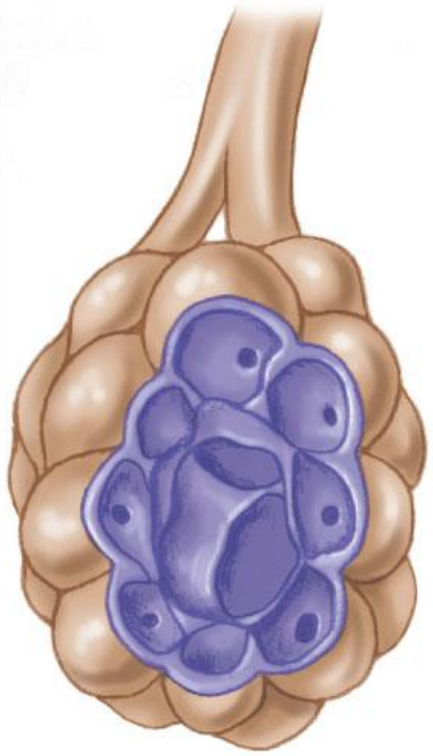
- Frontal impacts often result in significant exchange of energy and serious injuries

Down and Under Pathway

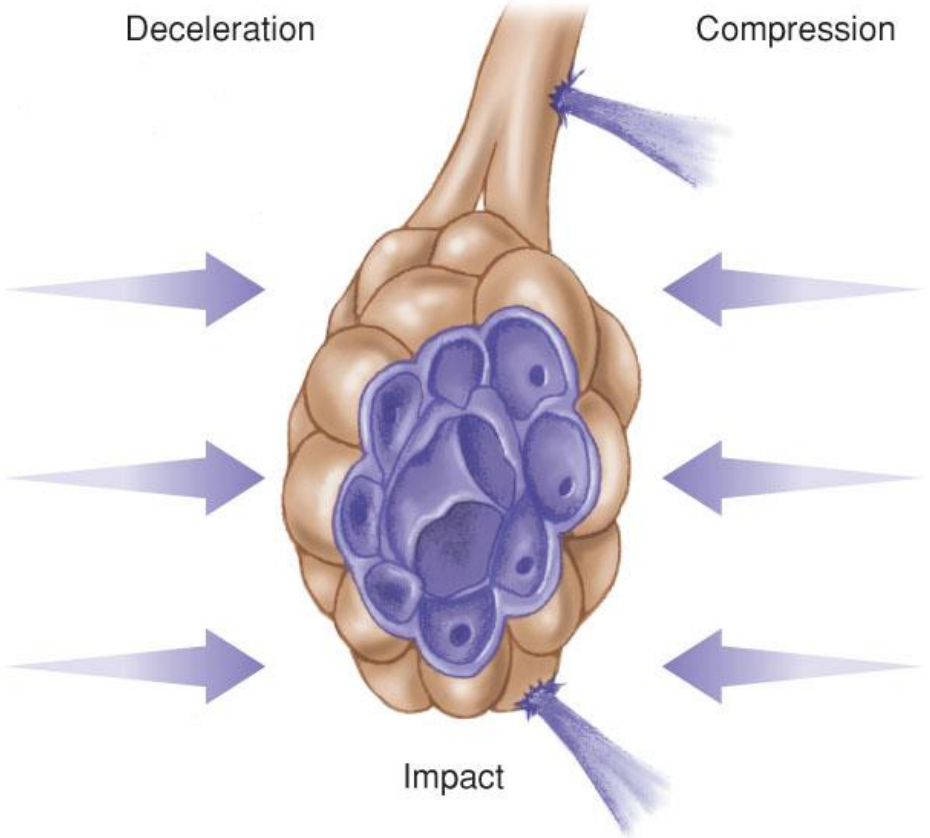
- Occupant slides downward as vehicle comes to a stop
- Knees come into contact with firewall and absorb the initial impact
  - Knee, femur and hip fracture or dislocations
- Upper body rotates forward and hits steering wheel
  - Chest trauma
- Driver may take a deep breath in anticipation of the impact
  - Paper bag syndrome

Injury Prediction?

Paper Bag Syndrome



Precrash



Up and Over Pathway

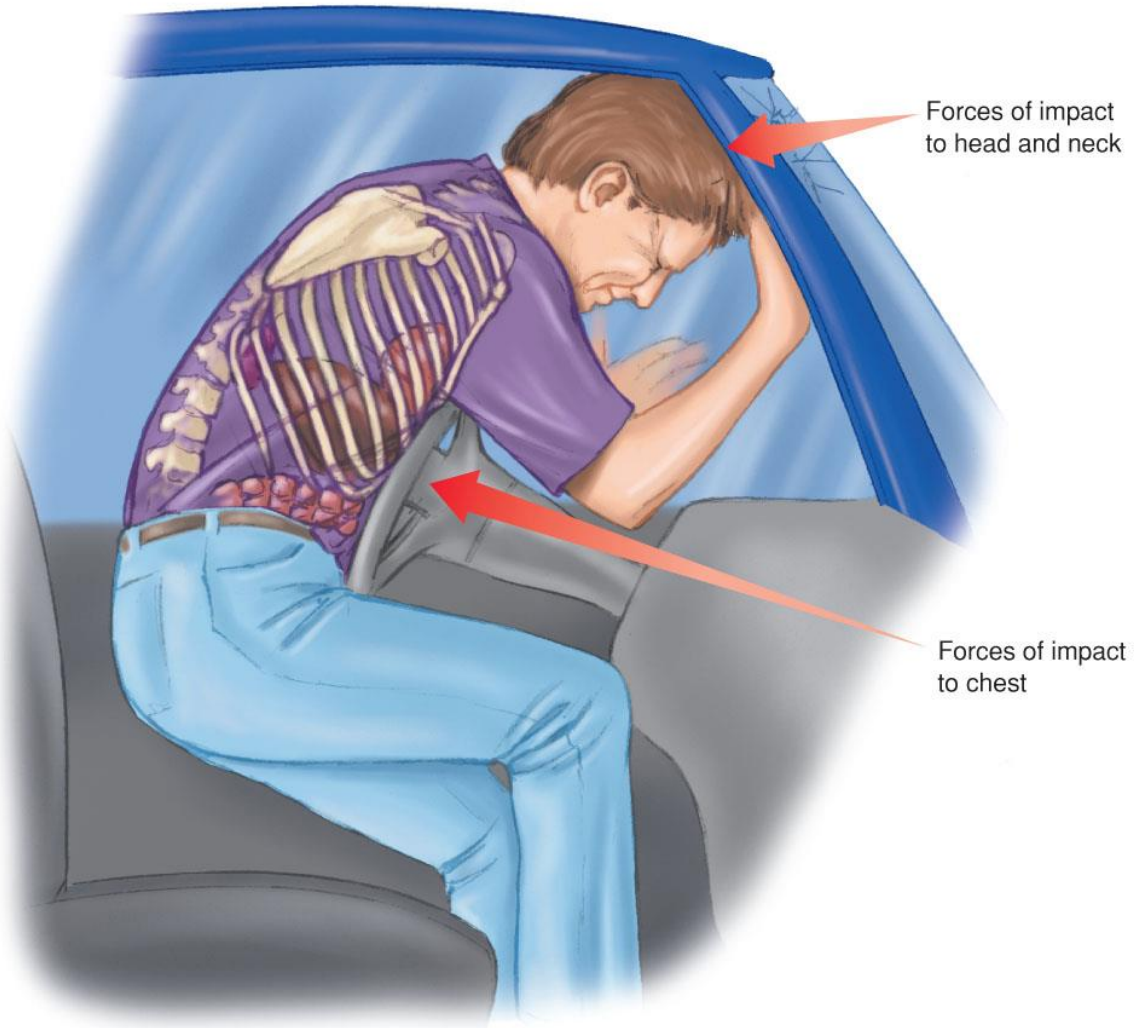
- Occupant tenses legs in anticipation of the impact
- Upper body pivots forward and upward
- Steering wheel impinges on the femurs
  - Possible bilateral fractures
  - Compresses and injures abdominal contents
- Lower chest strikes steering wheel
  - Thoracic injuries
- Forward motion propels head into windshield
  - Head and neck injuries
  - Axial loading

Up and Over Pathway

- Head leads the way
- Compression of cervical spine
- Chest/abdomen impacts steering wheel
- Compression of hollow and solid organs
- Shearing injuries

MEDAVIE HealthEd ÉduSanté

Up and Over Pathway



Injury prediction?

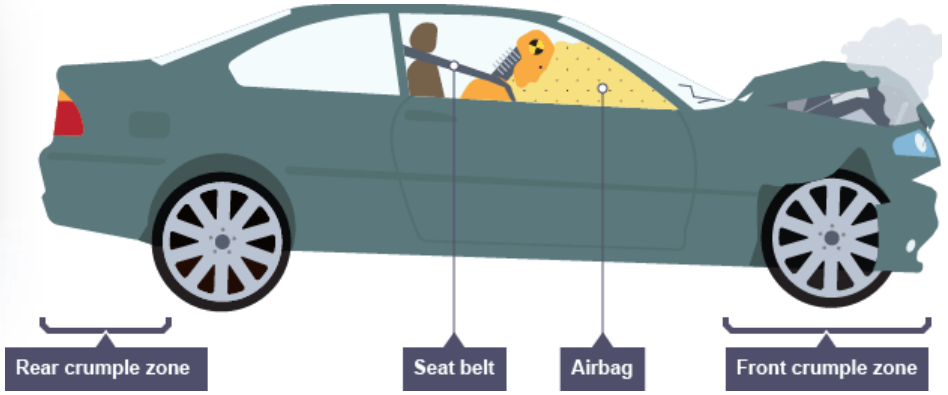
- Closed/open head injury - ALOC
- Facial fractures
- Airway problems
- Chest
- Abdomen

Ejection

- Due to up-and-over pathway
- Victims experience two impacts
  - Contact with vehicle interior and windshield
  - Impact with ground, trees or other objects
- Responsible for ~27% of vehicular fatalities

Crumple Zones

- Frontal impacts interpose more vehicle between the point of impact and patients
- Modern vehicles use this area to absorb impact forces and limit occupant injury
- Patients in collisions involving vans or lateral impacts do not benefit the same way



Crumple Zones

- A lateral impact presents the least amount of crumple zone

MEDAVIE HealthEd ÉduSanté

Case Study

Case Study

- Pre-Crash Considerations
  - Age of patients
    - Co-morbid factors, medications
    - Intoxication
  - Age of vehicles
    - Safety measures (50 years of research)
      - Crumple zones, airbags, seatbelts, telemetry
  - Speed, mass, impact type

Case Study

- Post-Crash Considerations
  - Response time – 5 minutes
  - Resources needed?
  - Prediction of injuries based on paramedic's knowledge of anatomy, kinematics?

Case Study

Driver A (Ford)

- Possible whiplash
- Cuts from flying glass
- Minor upper extremity injuries

Driver B (Toyota)

- Head
- Neck
- Face (airway)
- Chest (multiple)
- Abdomen – shearing / compression
- Pelvis
- Upper and lower extremities

Blunt Trauma

LATERAL IMPACT

Lateral Impact

- 15% of MVC's but 22% of deaths
- Kinetics the same as in a frontal impact
- Two exceptions:
  - Occupants present a different profile
  - Less structural steel to protect occupants

Lateral Impact

- Intrusion into the passenger compartment
- Often an intersection crash
- Vehicle is accelerated in the direction of impact
- What would Newton say about this?

MEDAVIE HealthEd ÉduSanté

Lateral Impact

Lateral Impact

- Increased upper extremity injuries
  - Lateral rib fractures
  - Head and neck injuries
- Lateral compression
  - Ruptured diaphragm, spleen fracture, aortic injury
- Consider any unrestrained passengers
  - Becomes an object that will collide with driver

Blunt Trauma

ROTATIONAL IMPACT

Rotational Impact

- Vehicle struck at oblique angle
- Energy exchange generally more gradual
  - Deflected form path rather than stopped
  - Longer stopping distance
  - Deceleration more gradual
- Less serious injuries unless there are multiple impacts

Blunt Trauma

REAR END IMPACT

Rear-End Collision

- Seat propels the occupant forward
  - Generally good protection for the body
  - Poor protection for the head
- Head is forced backwards and then forwards
  - Stretching of neck muscles and ligaments
  - Hyperextension and hyperflexion

Rear-End Collision

a. Victim moves ahead while head remains stationary. Head rotates backward. Neck extends.

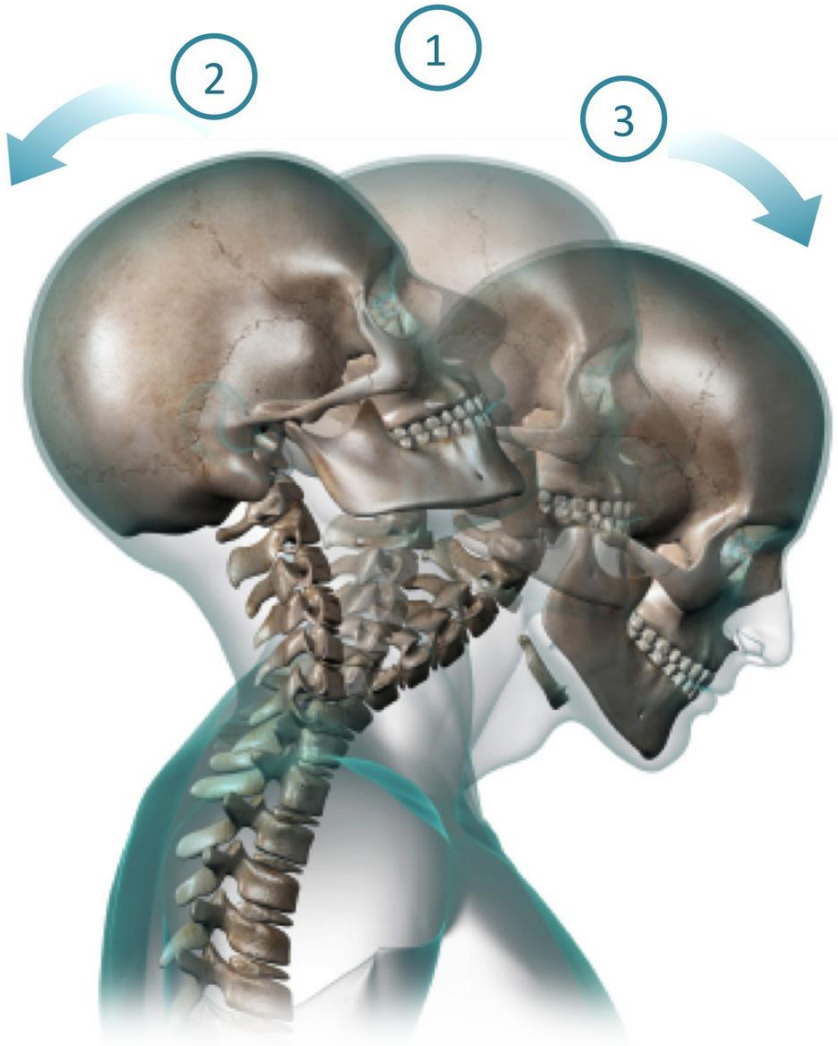
b. Head snaps forward. Head rotates forward. Neck flexes.

Rear-End Collision

- Properly placed headrests help lessen injury
- Frontal impact on the target car after rear impact increases the likelihood of injury

Injury Prediction?

- Hyperextension of the neck may occur with improperly placed/absent headrest
- Rapid deceleration may follow if the target car strikes another object or brakes



Injury Prediction?

Blunt Trauma

ROLL OVER

Rollover

- Generally caused by:
  - Change in elevation
  - Vehicle with high centre of gravity
- Occupant experiences impact at each impact of vehicle
- Often involves ejection or partial ejection
- Injuries are usually compounded by multiple subsequent impacts

- Rollover collisions result in multiple impacts and potentially multiple injuries

Injury Prediction?

MEDAVIE HealthEd ÉduSanté

Blunt Trauma

COLLISION ANALYSIS

Vehicle Collision Analysis

- Hazards
- Crumple zones
- Intrusion
- Deformity of vehicle
- Use of restraints

Hazards

- Heat
  - Hot engine and transmission parts
  - Hot fluids (radiator coolant, engine oil)
- Caustic substances
  - Battery acid, automatic transmission fluid, steering fluids
- Sharp jagged edges of metal and broken glass

Intoxication

- 36.5% of deaths on Canadian Highways were alcohol related (2001 CCMTA statistics)
- Patient effects:
  - Alters level of consciousness
  - Masks signs and symptoms of injury
  - Anesthetizes patient somewhat
- Makes mechanism of injury analysis and index of suspicion even more important
  - Otherwise significant injuries may be missed

Vehicular Trauma

Table 17-1 Motor Vehicle Injuries

(Incidence by Body Area)

Head	4 067	26.2%
Orthopedic	3 944	25.4%
Superficial	3 847	24.8%
Internal	2 425	15.6%
Spinal Cord	337	2.2%
Blood Vessels	301	1.9%
Burns	223	1.4%
Nerves	194	1.3%
Other	158	1.0%

Source: NTR/CIHI, 2003. Percentages don't add to 100 due to rounding.

Collision Evaluation

- Collision Questions
  - How did the objects collide?
  - From which direction did they come?
  - At what speed were they travelling?
  - Were the object similarly or different sized?
  - Were there any secondary collisions or additional transfers of energy?

Collision Evaluation

- Cause of Collision
  - Did wet roads or poor visibility contribute to the crash?
  - Was alcohol involved?
  - Are there skid marks? Was the driver prevented from braking?

Collision Evaluation

- Auto Interior
  - Does the windshield show evidence of an impact?
  - Is the steering wheel deformed or collapsed?
  - Is the dash indented where the knees or head hit it?
  - Has the impact extended into the passenger compartment?

MEDAVIE HealthEd ÉduSanté

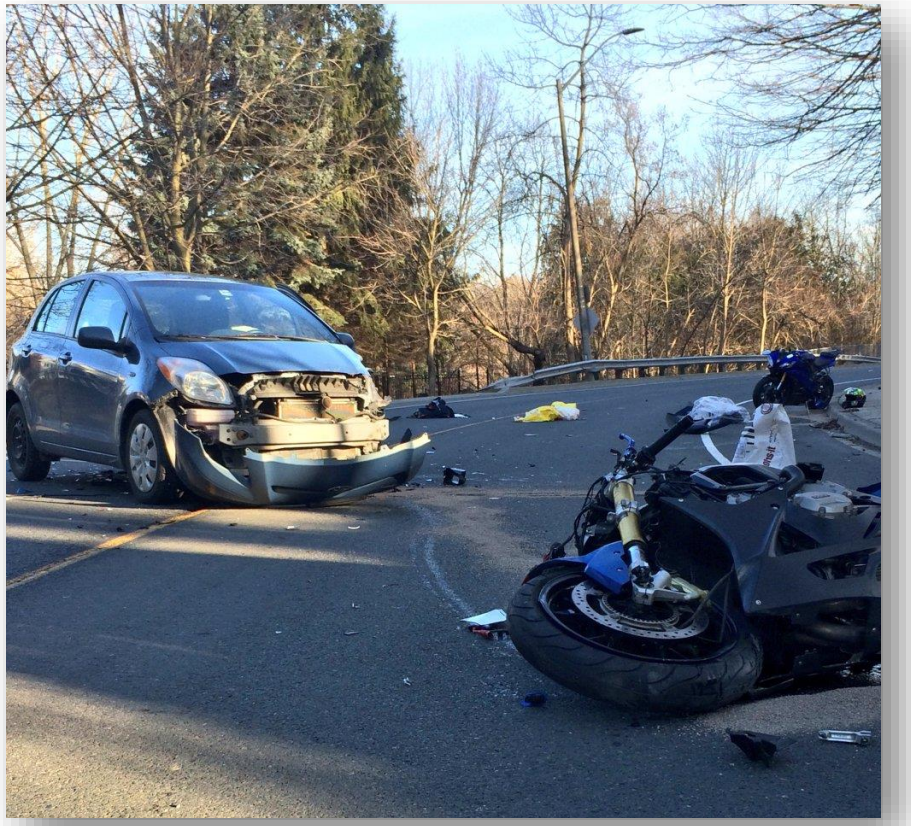
Blunt Trauma

MOTORCYCLES

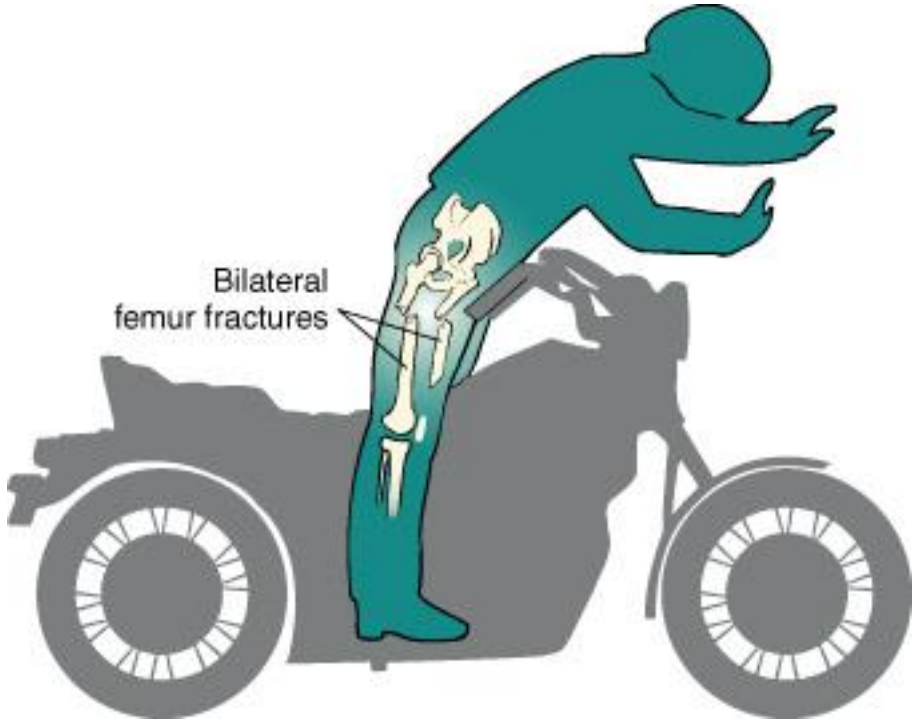
- Motorcycles provide little protection for their riders during a collision

Motorcycle Collisions

- Often result in serious trauma even at low speed
  - Driver absorbs most of impact
- Impacts
  - Frontal
  - Angular
  - Sliding
  - Ejection
    - Initial Bike/object collision
    - Rider/object
    - Rider/ground



Motorcycle Collisions



- Impact stops the vehicle
- Center of gravity is above and behind the front axle, making it the pivot point
- Riders are ejected over the handlebars; impacting thighs
  - Bilateral femur/pelvic fractures are common
  - Secondary impact with stationary object or ground
  - Tertiary impact with moving traffic including target vehicle

Motorcycle Collisions

- Angular impact
  - Rider caught between bike and another object
  - Crush injuries to affected side
    - Open fractures of femur, tibia, fibula
    - Fracture dislocation of malleolus

Motorcycle Collisions

- Laying the motorcycle down
  - Massive abrasions
  - Fractures of affected side

Motorcycle Collision Ejection

- Injury occurs at point of impact and radiates throughout body as energy is transformed
- Laying down the bike can result in extensive skin damage in unprotected riders

Personal Protective Equipment

- Riders of small motor vehicles
  - Boots
  - Leather clothing
  - Eye protection
  - Helmets
    - Absorb energy, reduce head and facial injuries
    - Helmet non-use increases head injuries > 300%

Case Study

- Two occupants on a motorcycle strike a moving car in a frontal/lateral impact pattern

Motorcycle Collisions

- Pre-Crash Considerations
  - Age of patients
    - Co-morbid factors, medications
    - Intoxication
  - Ejection issues
    - Other traffic, protective equipment
  - Speed, mass, impact type

Case Study

- Post-Crash Considerations
  - Response time – 3 minutes
  - Resources needed?
  - Prediction of injuries based on paramedics knowledge of anatomy, kinematics?

MEDAVIE HealthEd ÉduSanté

Blunt Trauma

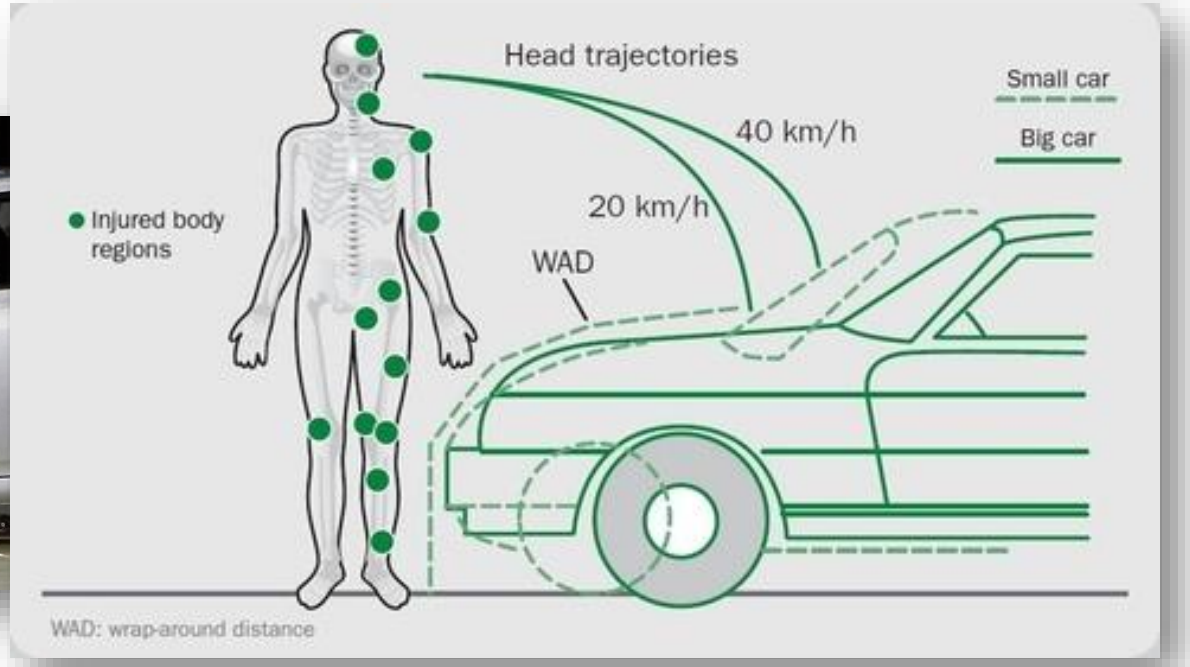
PEDESTRIAN

Pedestrian Accidents

- Adults
  - Adults turn away
  - Bumper strikes lower legs first
  - Victim rolls up and over and thrown
- Children
  - Children turn toward
  - Thrown in front of car
  - Femurs, pelvis often injured

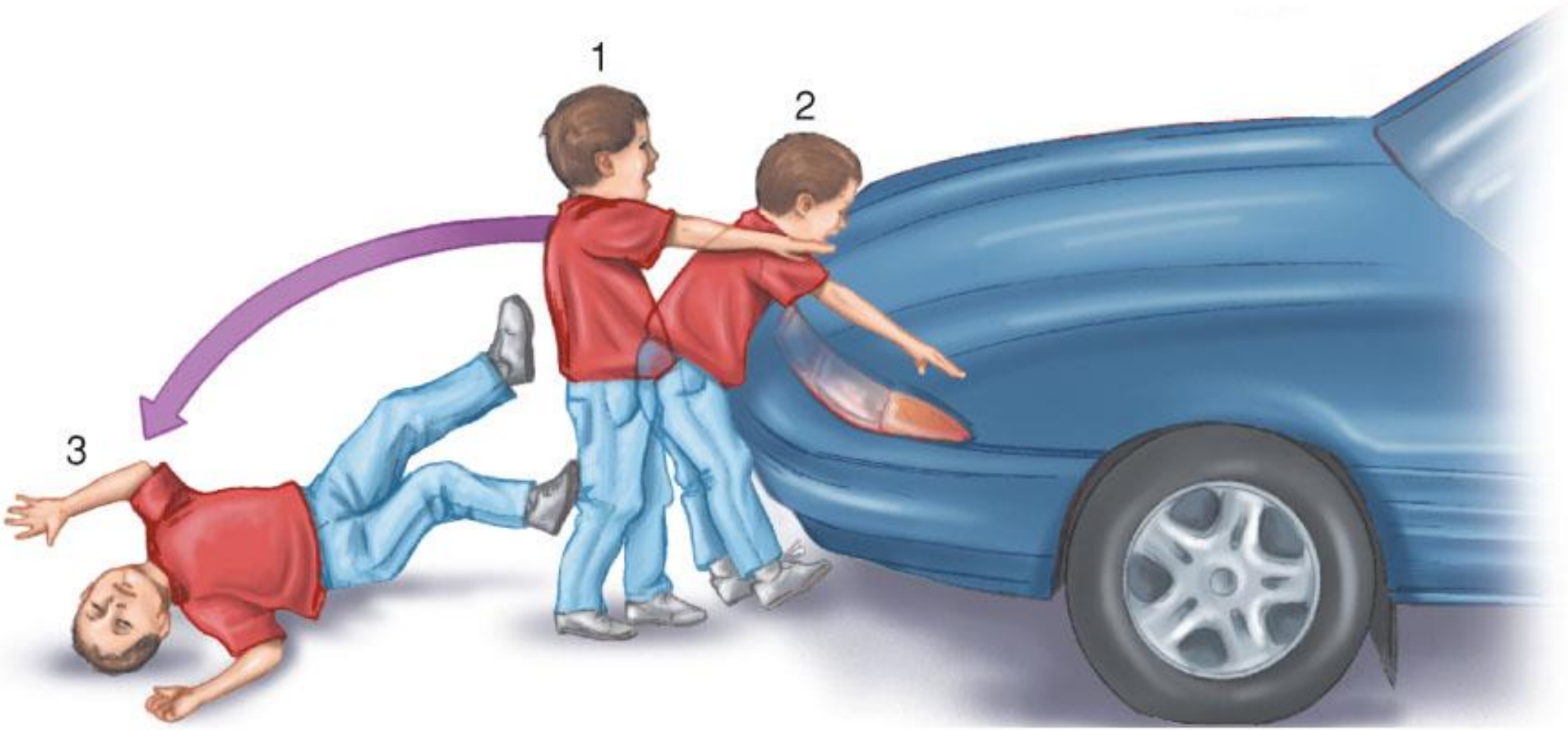
Car-Pedestrian - Adult

- Crash phases vary by height relative to vehicle
  - Initial impact to lower extremities/hips
  - Torso rolls onto hood
  - Victim falls to ground, often head-first



MEDAVIE HealthEd ÉduSanté

Pediatric Pedestrian



Blunt Trauma

RECREATIONAL VEHICLES

Recreational Vehicles

- Lack structure and restraint system
  - Little protection offered to occupants
- Types of Vehicles
  - Snowmobiles
  - Personal watercraft
  - ATV’s

Recreational Vehicles

- Speeds can be comparable to cars and motorcycles
- Usually result in ejection and/or rollover injuries

Recreational Vehicles

- Watercraft accident also present risks of drowning and hypothermia

Recreational Vehicles

- ATVs cause a multitude of injuries due to speed, instability and lack of protection

MEDAVIE HealthEd ÉduSanté

Blunt Trauma

BLAST INJURIES

Blast Injuries

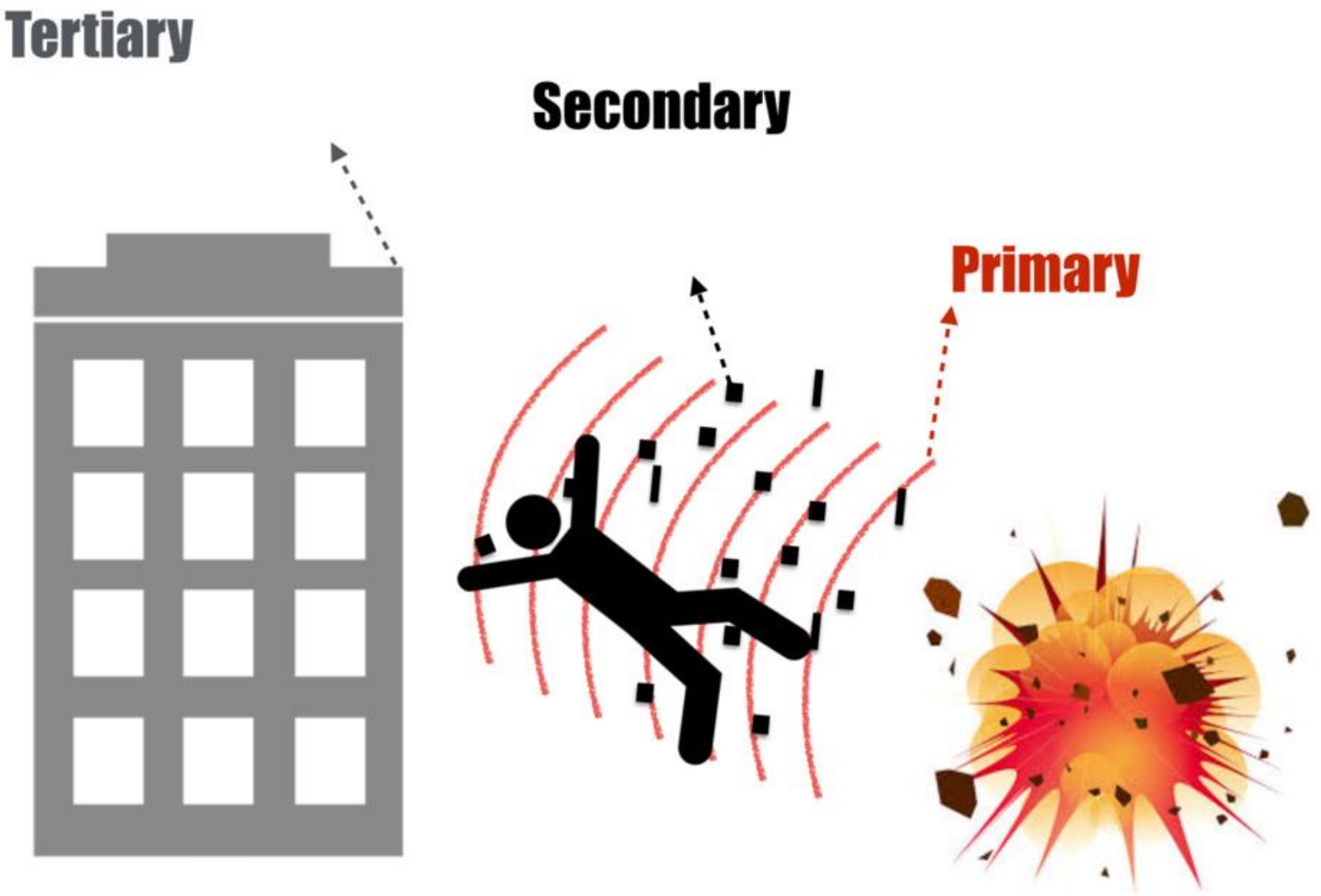
- Causes:
  - Dust (e.g. grain elevator)
  - Fumes (e.g. gasoline or natural gas)
  - Explosive compounds
- Magnitude ranges from small fire cracker to a nuclear explosion
- May be accidental or an act of terrorism

Mechanisms of a Blast

- Explosion
- Pressure wave
- Blast wind
- Projectiles
- Personnel displacement
- Confined space explosions and structural collapses
- Burns

Blast Injury Phases

- Primary
  - Caused by heat of explosion and pressure wave
- Secondary
  - Caused by blast projectiles
- Tertiary
  - Caused by personnel displacement and structural collapse


Tertiary
Secondary
Primary

Blast Injury Assessment

- Survey and assess scene
  - Be aware of potential for secondary device
  - Secure further EMS operations
- Triage
- Establish Incident Command System if necessary
- Evaluate for secondary hazards

Common Injuries

- Lungs
  - Pressure wave rapidly compresses and distorts chest, lungs and alveoli
  - Ruptures alveolar walls
  - Fluid accumulation and hemorrhage
  - High risk of emboli formation
- Abdomen
  - Rapid compression and decompression
  - Bowel wall may hemorrhage or rupture
  - Release of bowel contents into abdomen

Common Injuries

- Ears
  - Eustachian tube cannot equalize pressure
  - Stretching or rupture of tympanic membrane
  - Often fracture of small bones of hearing
  - Hearing loss may be temporary or permanent
- Penetrating Wounds
  - Care as any serious open wound or impaled object
- Burns
  - Treatment consistent with traditional management

MEDAVIE HealthEd ÉduSanté

Blunt Trauma

FALLS

Falls

- Release of stored gravitational energy
- Potential for injury depends on:
  - Height
  - Stopping distance

Factors

- Nature of impact surface contour
  - Stairway may focus force of impact , increasing seriousness of injury
- Area of contact and pathway of energy transmission
  - Energy transmitted up skeletal structure
- Age related factors
  - Common problem in elderly

Falls

“It’s not so much the falling, it’s the stopping”

- Falls from more than 3X patient height are severe
- Velocity increases with height
- Landing surface affects stopping distance (deceleration)

Falls

- Colle’s fractures, clavicle fractures, shoulder dislocation
- Other patterns: consider pathway of energy exchange

Falls

- Energy absorption occurs vertically through lower extremities to spine
- Compression occurs because of continued downward movement of body
- Expect hyperflexion and compression injuries of spine; shearing injuries

MEDAVIE HealthEd ÉduSanté

Blunt Trauma

SPORTS INJURIES

Sports Injuries

- Injuries most commonly produce by extreme exertion, fatigue or direct trauma
  - Variety of injury patterns
  - Often exchange of great kinetic forces producing serious injuries
- Alterations in patient LOC result in:
  - Exclusion from further activity
  - Follow up with a physician

- Contact sports result in the exchange of great kinetic forces

Protective Gear

- Greatly reduces potential for injury
  - May also cause injuries e.g. cleats may cause torn ligaments as the foot is fixed while the knee is twisted
- Helmet
  - If loose remove
  - If tight, remove face mask and immobilize in place
  - Take helmet to hospital

Summary

- Kinetics of blunt trauma
- Types of trauma
- Blunt trauma
  - Automobile collisions
  - Blasts
  - Falls
  - Sports injuries
  - Crush injuries