# Mechanism v Injury Pattern

**Dr James P Gray** ***MB BCh BAO BA AFRCSI DFLM FRCEM***
**UHL Consultant in Emergency medicine**
**UL Adjunct Senior Clinical Lecturer EM**
**RCEM Senior examiner EM**
**Expert Witness EM**

**CPD Study Day 12/09/2022**

# Injury

- Kinetic
  - Penetrating
  - Blunt
- Blast/explosion
- Thermal
- Chemical
- Radiation
- Electrical

# Incised v stab wound

www.rcemlearning.org

# Bullet trauma

Loose contact

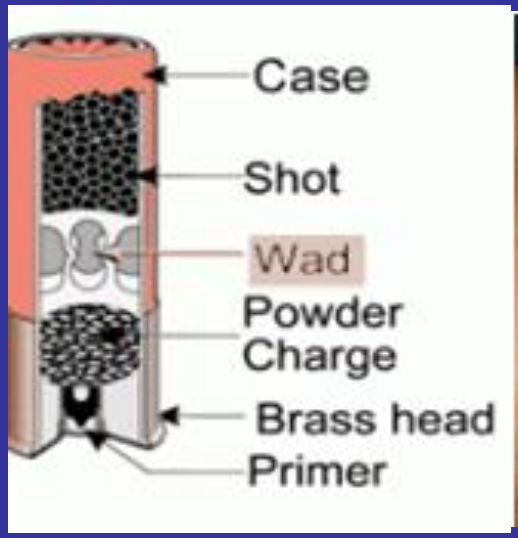
Intermediate range with tattooing from powder.

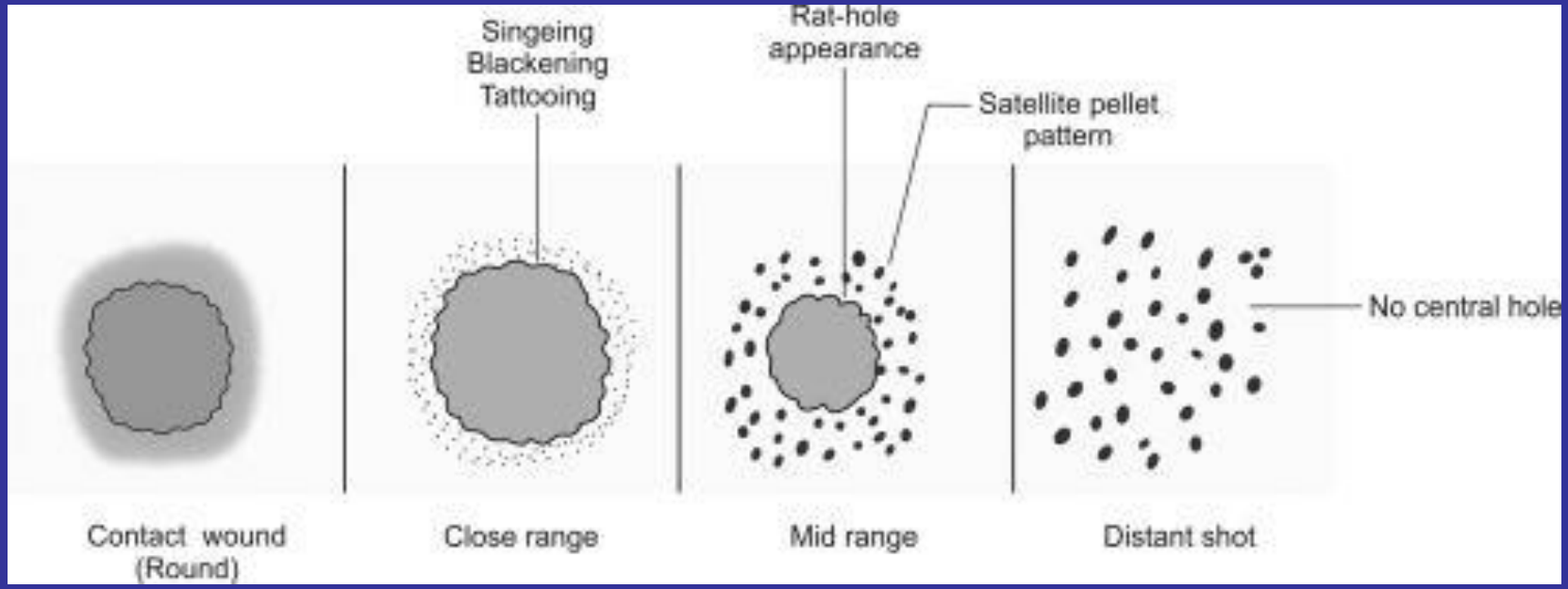

Distant shot – no soot / tattooing


Contact shot

www.acepnow.com

# Shotgun trauma



# Laceration

www.rcemlearning.org

# Abrasion v bruise v tramline bruise


www.rcemlearning.org

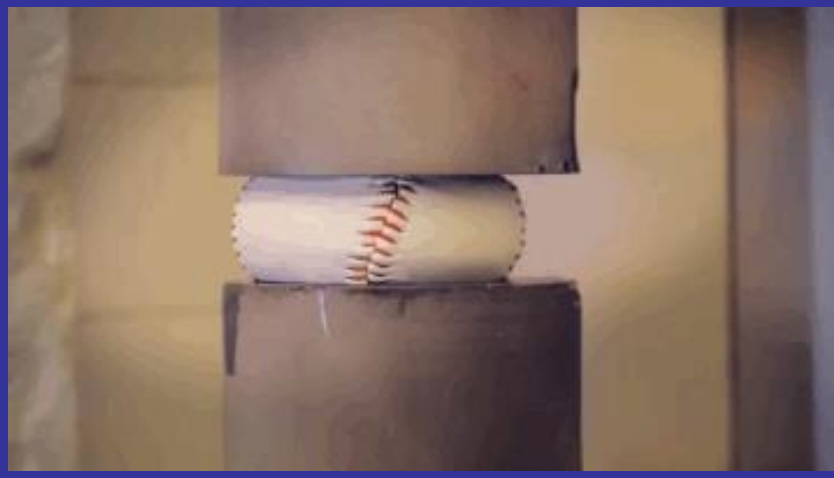
# Bite v petechial v haematoma

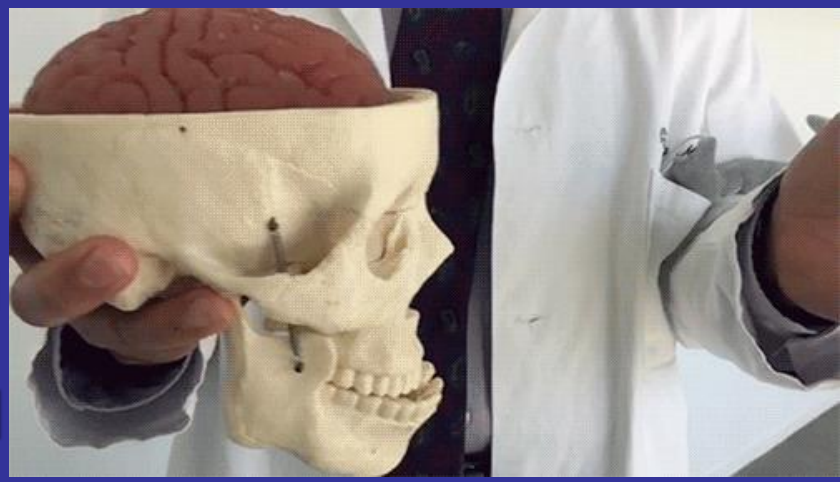
www.rcemlearning.org

# Blunt Force Mechanism

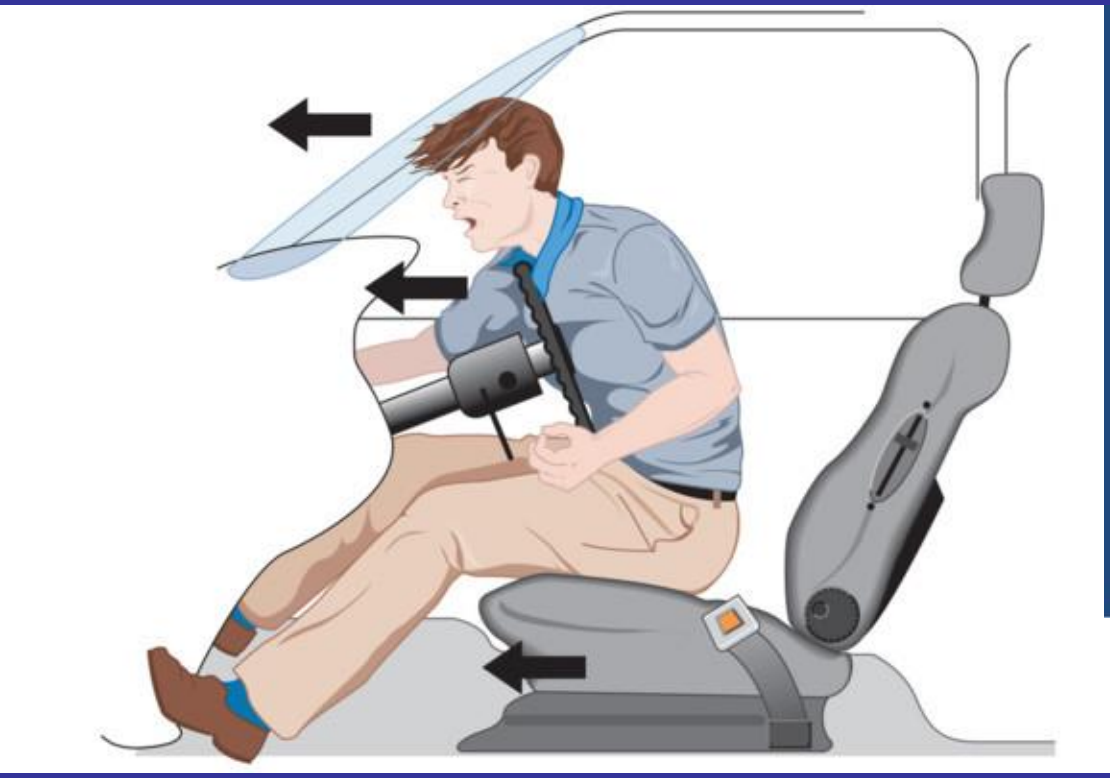
## How does it injure?

- Compression/Crushing
  - Myocardial, lung, abdo organs, closed glottis injury, brain
- Shearing / Deceleration (pedicle)
  - Brain, C7/T1, descending thoracic aorta, renal, spleen, liver, small bowel





# Compression Injury



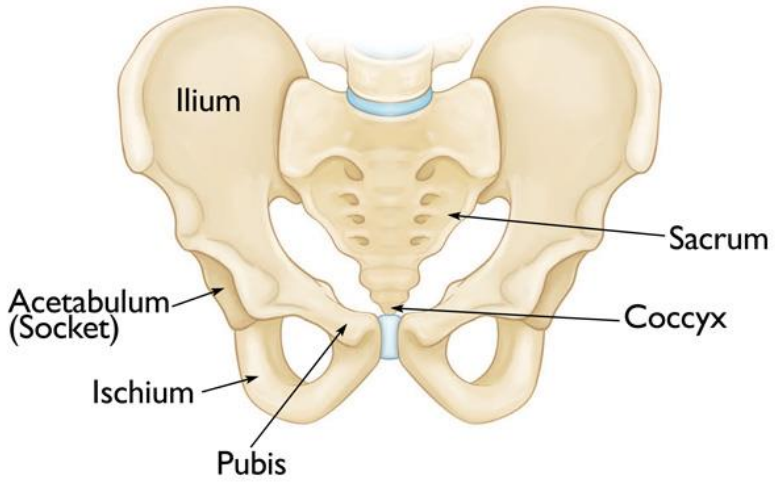
MYOCARDIAL CONTUSION


101

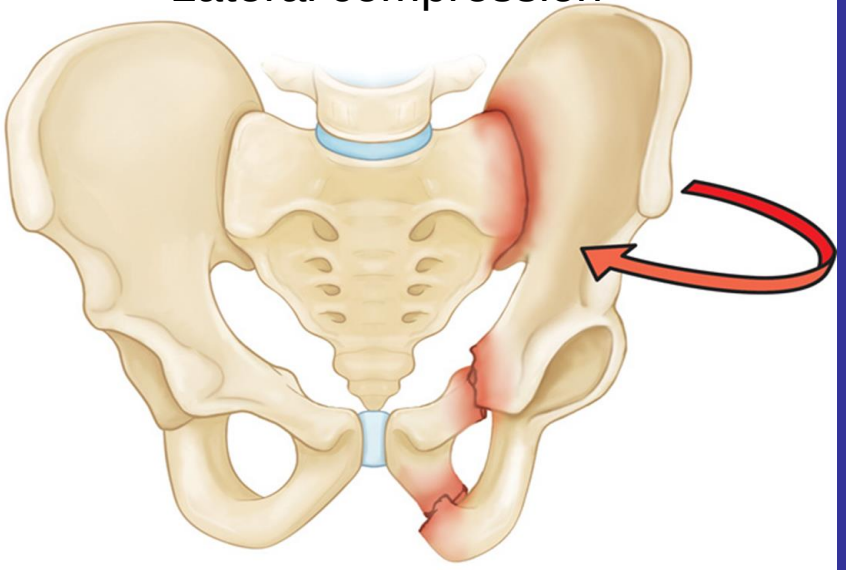
Compression Fracture

# Pelvic Fractures

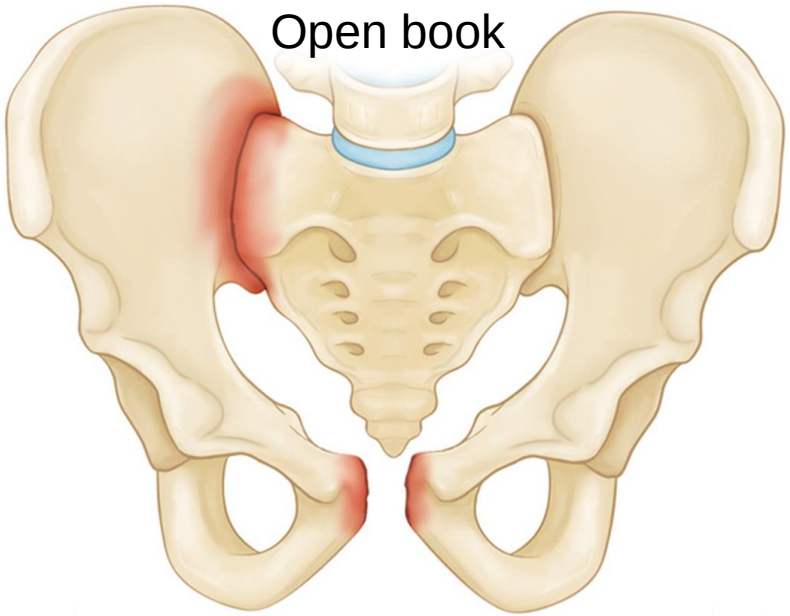
ATLS 10e



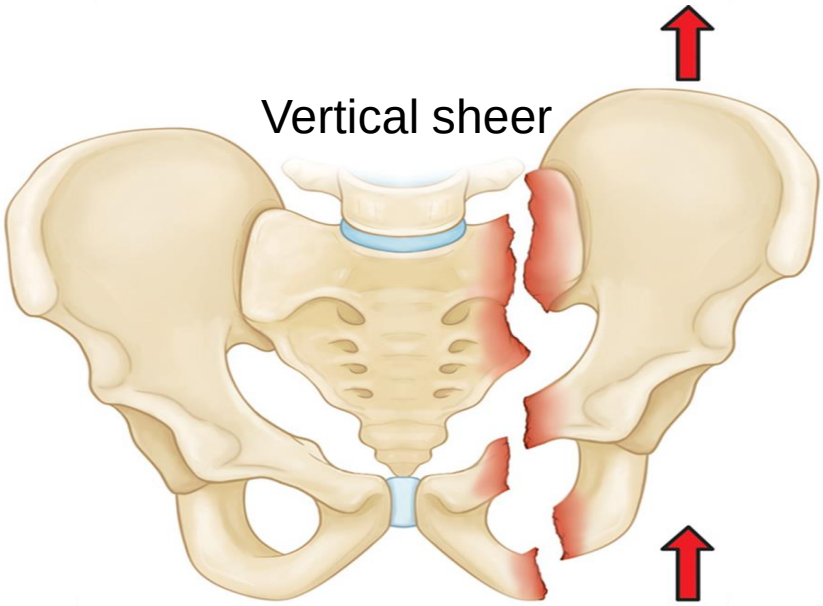

Lateral compression



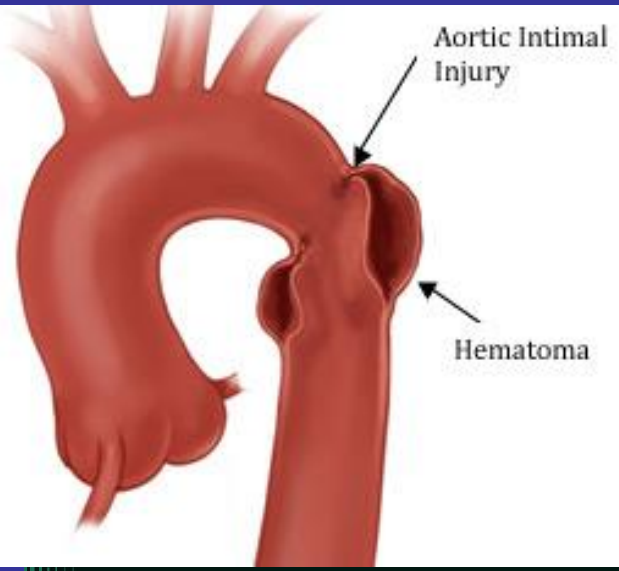
Open book

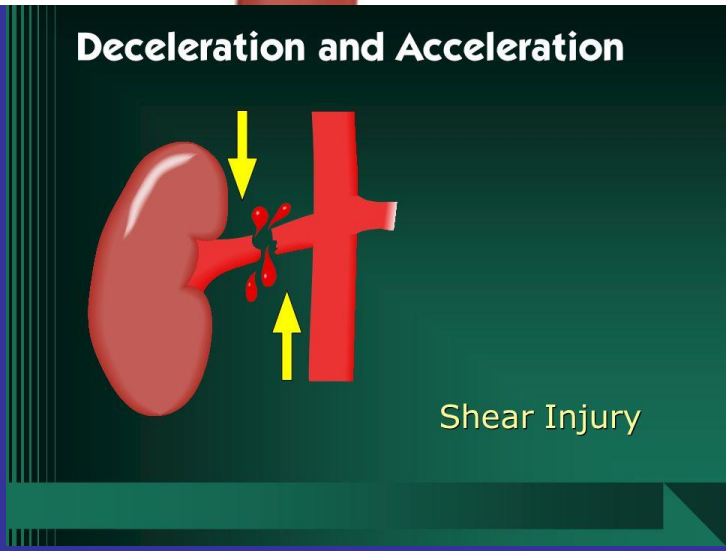


Vertical sheer



# Deceleration



# Blunt trauma abdo injuries[1]

**Mix of compression/crushing and deceleration**
**What organs are commonly injured?**

- **Spleen 40 - 55%**
- **Liver 30 - 40%**
- **Small bowel 5 - 10%**

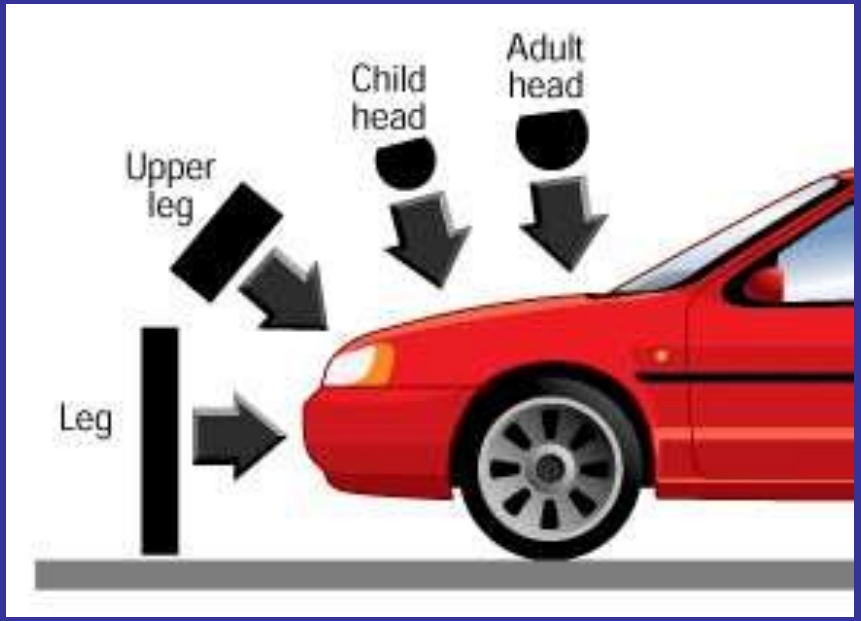
1. ATLS 10e

# Blunt Trauma

- Vehicular Impact
- Pedestrian
- Cyclist
- Assaults
- Falls
- Blast

# Vehicular Impact

- Frontal
- Side on
- Rear-end
- Quarter-panel
- Roll-over
- Ejection
- Pedestrian
- Cyclist




| Injury Mechanism | Related Injuries |
|---|---|
| Seat belt–related injuries (increased suspicion with clinical or CT seat belt sign) | Superficial soft tissues: abdominal wall musculature<br>Neck: laryngotracheal injury<br>Spine: flexion-distraction injuries, C7 and T1 transverse process fractures<br>Thoracic: rib and costal cartilage fractures (coronal images with soft-tissue window), sternum, anterior mediastinum, lungs<br>Abdominal: duodenum, bowel and mesentery, pancreas<br>Pelvic: pelvic ring injury, bladder rupture<br>Vascular: subclavian, vertebral, and carotid arteries, thoracoabdominal aorta |
| Steering wheel– and windshield-related injuries (increased suspicion with forehead contusion or knowledge of steering wheel deformity found at crash site) | Head and neck injuries: facial and skull base fractures, blunt cerebrovascular injury, laryngotracheal crush injuries<br>Spine injuries: cervicothoracic hyperextension injuries; craniocervical dissociation; occipital condyle, C1, and C2 fractures; cervical flexion-distraction injuries<br>Thoracic: rib and sternal fractures, aortic injuries<br>Abdominal injuries: solid organ injuries<br>Extremities: axial load on outstretched hands |
| Dashboard-related injuries | Hip dislocation<br>Direction of dislocation (posterior, anteroinferior, anterosuperior)<br>Acetabular fracture<br>Femoral head or neck fracture<br>Postreduction CT: location of bone fragments, new fracture<br>Knee injuries<br>Patellar fracture<br>Tibial plateau fracture<br>Posterior cruciate ligament injury or posterior knee dislocation, popliteal vascular injury<br>Femoral condyle (Hoffa) or shaft fracture |
| Floorboard-related injuries | Metatarsal and tarsal fractures (including talar dome or body, talar neck, lateral talar process, and calcaneus)<br>Lisfranc, Chopart, and subtalar joint malalignment (consider stress views)<br>Tibial or fibular fractures (pilon, shaft, and tibial plateau) |
| Side-impact injuries | Head and neck: coup and countercoup brain injury, skull fracture, blunt cerebrovascular injury<br>Spine: lateral flexion injuries, facet joint subluxation or dislocation, with particular attention to the C7-T1 level<br>Thoracic: rib fractures, aorta, diaphragm<br>Abdominal: solid organ injuries<br>Pelvis: lateral pelvic compression injuries (unilateral or bilateral) |

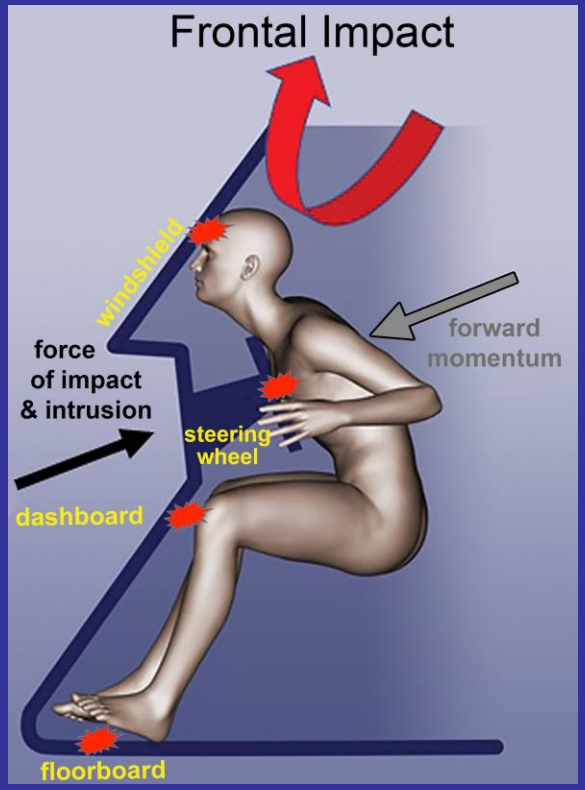
https://pubs.rsna.org/doi/full/10.1148/rg.2019180063

# Vehicular Injuries

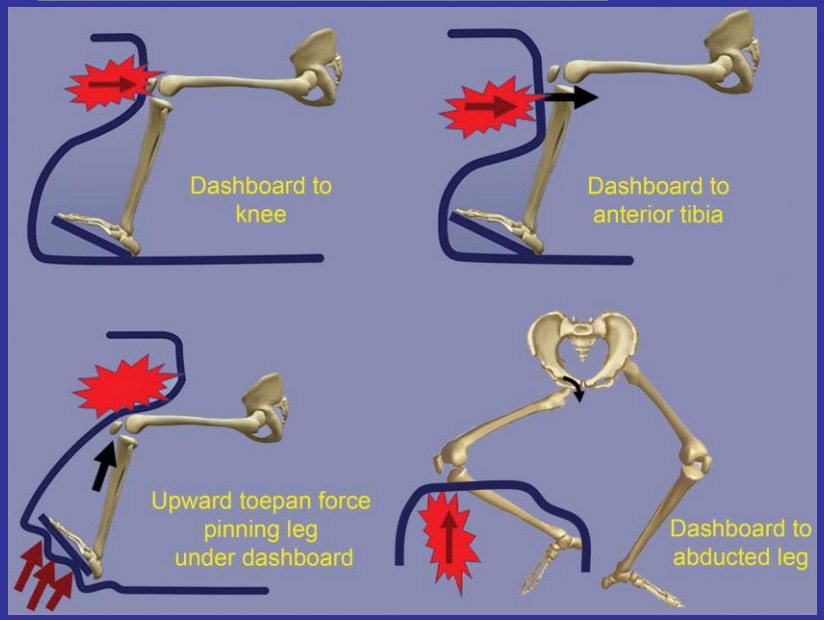
- Frontal
  - Forehead, face, Chance #, chest/sternal, restraint injury, # / dislocation(hip, knee, ankle).
- Side
  - Side of head, C-spine #, rib #/pulmonary contusion, diaphragmatic rupture, liver/spleen, pelvic #
- Rear
  - WAD, posterior C-spine #, rear ejection (seat failure)
- Quarter-panel
- Roll-over
- Ejection

# Get ready…

# Frontal

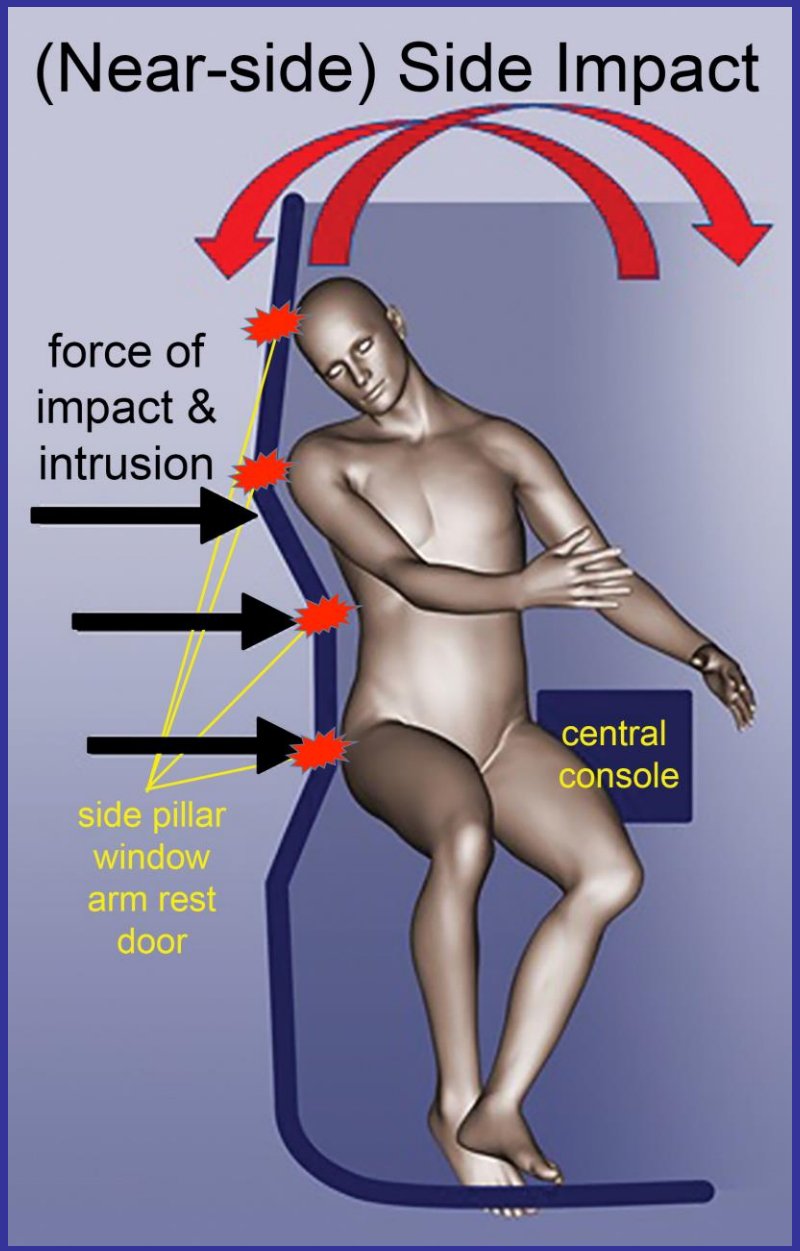


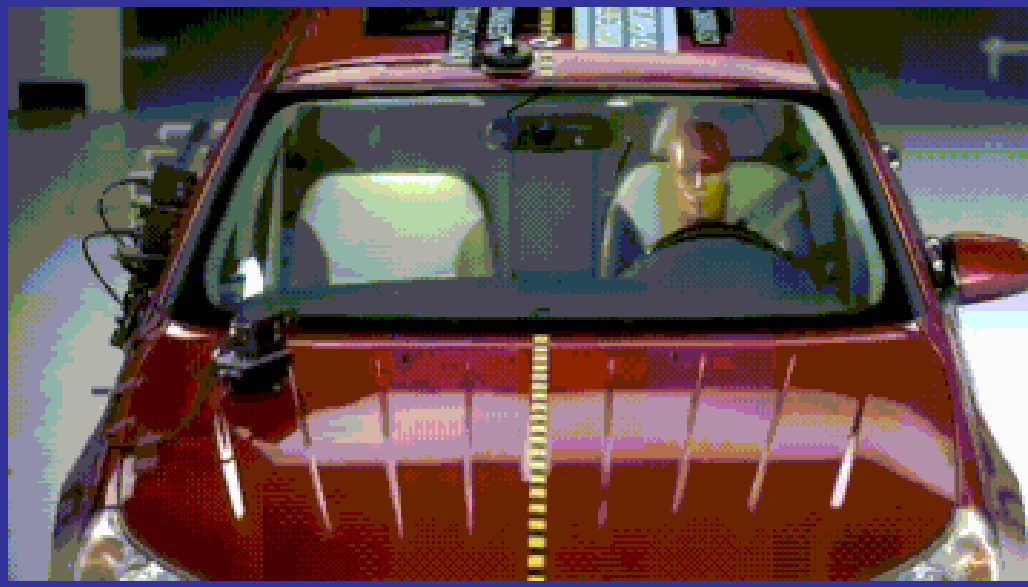





https://pubs.rsna.org/doi/full/10.1148/rg.2019180063

# Side impact

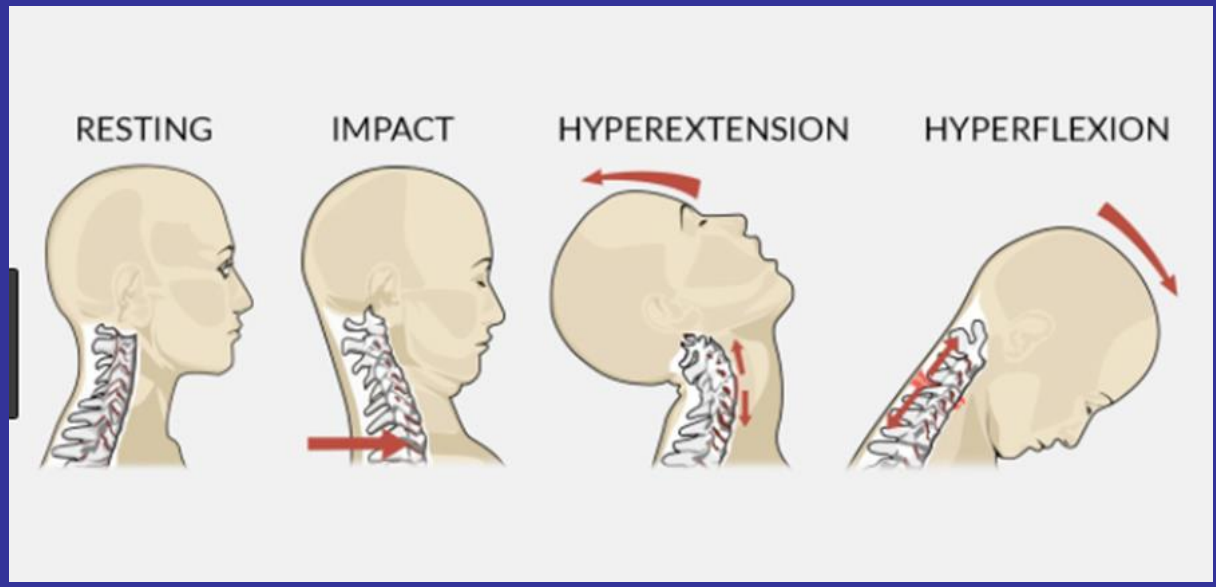


https://pubs.rsna.org/doi/full/10.1148/rg.2019180063#_i43

# Rear-end

https://www.welcomebackclinic.com/blog/Whiplash---Neck-Injury.htm



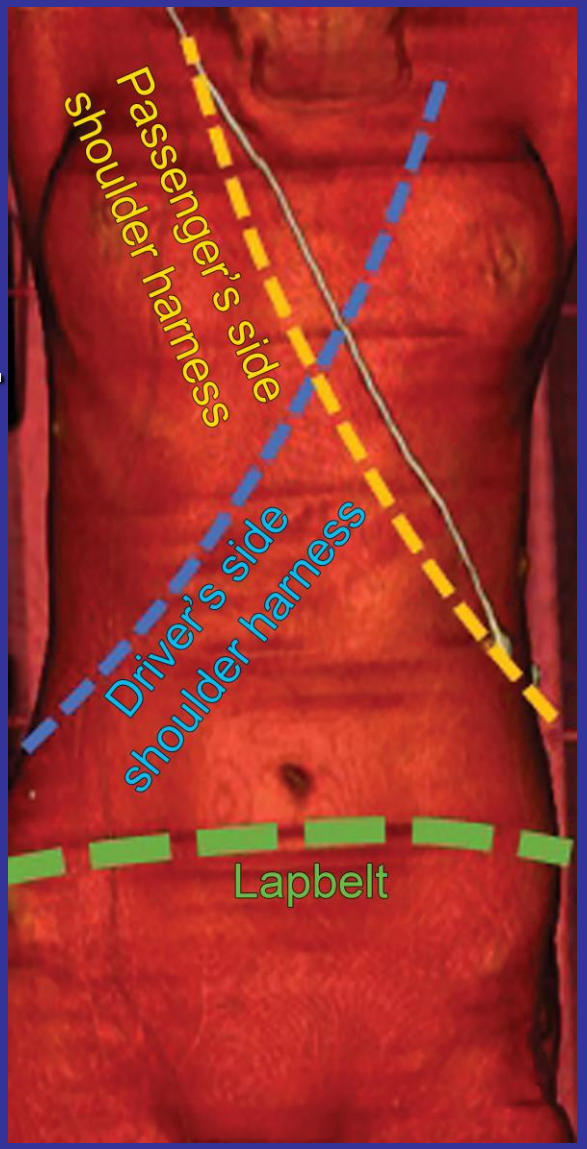

**Whiplash Associated Disorder (WAD)**

| Grade | Description |
|---|---|
| 0 | Whiplash injury but no pain, symptoms or signs. |
| 1 | Delayed neck pain, minor stiffness, non-focal tenderness only, no physical signs. |
| 2 | Early onset of neck pain, focal neck tenderness, spasm, stiffness, radiating symptoms. |
| 3 | Early onset of neck pain, focal neck tenderness, spasm, stiffness, radiating symptoms and signs of neurological deficit. |
| 4 | Neck complaint (grade 2 or 3 above) and fracture dislocation. |

# Restraints/airbags[1,2]

- Seat belt: 3 point harness
  - Reduced mortality by 65 – 70%
  - Reduced serious morbidity 10 fold.

- Airbag frontal impact
  - Mortality reduced by 30%




1. ATLS10e

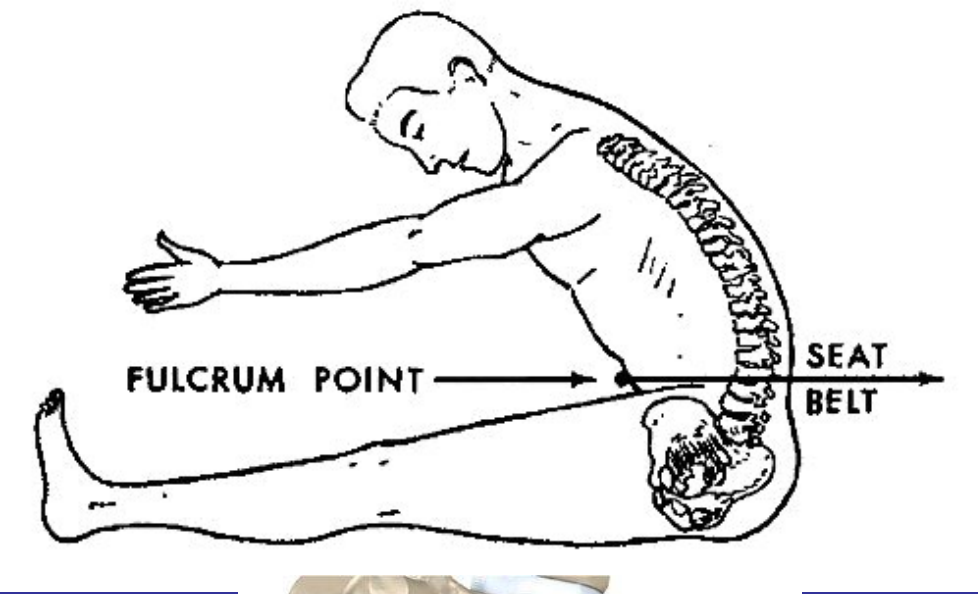
2. https://pubs.rsna.org/doi/full/10.1148/rg.2019180063

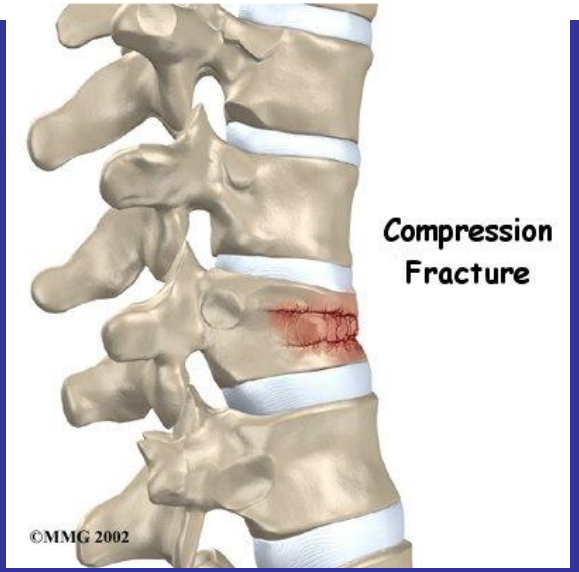
# Restraint device: lap seat belt

**Mechanism:**
- Compression
- Hyperflexion

**Injury:**

- Tear or avulsion of mesentery (Bucket Handle)
- Rupture of small bowel or colon
- Thrombosis of iliac artery or abdominal aorta
- Chance fracture of lumbar vertebrae
- Pancreatic or duodenal injury



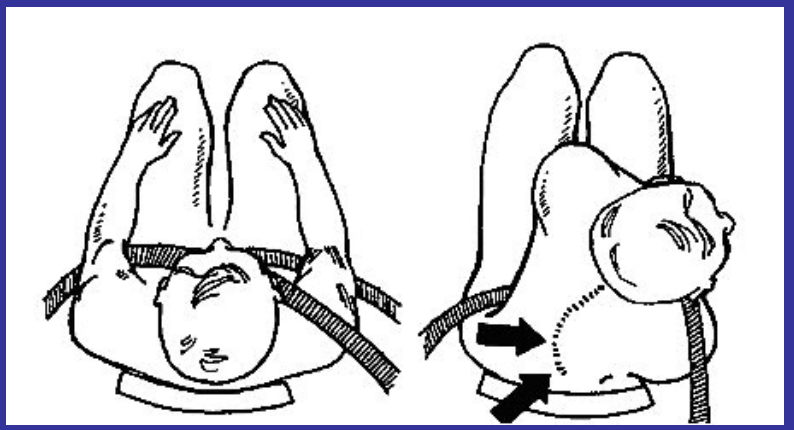
# Restraint device: shoulder harness

**Mechanism:**

- Sliding under the seat belt ("submarining")
- Compression
- Rotational torso forces

**Injury:**

- Intimal tear or thrombosis in innominate, carotid, subclavian, or vertebral arteries
- #/ dislocation of cervical spine
- Rib #, chest wall injury, sternum #, clavicle #
- Pulmonary contusion
- Rupture of upper abdominal viscera
- Breast injury



# Restraint device: airbag

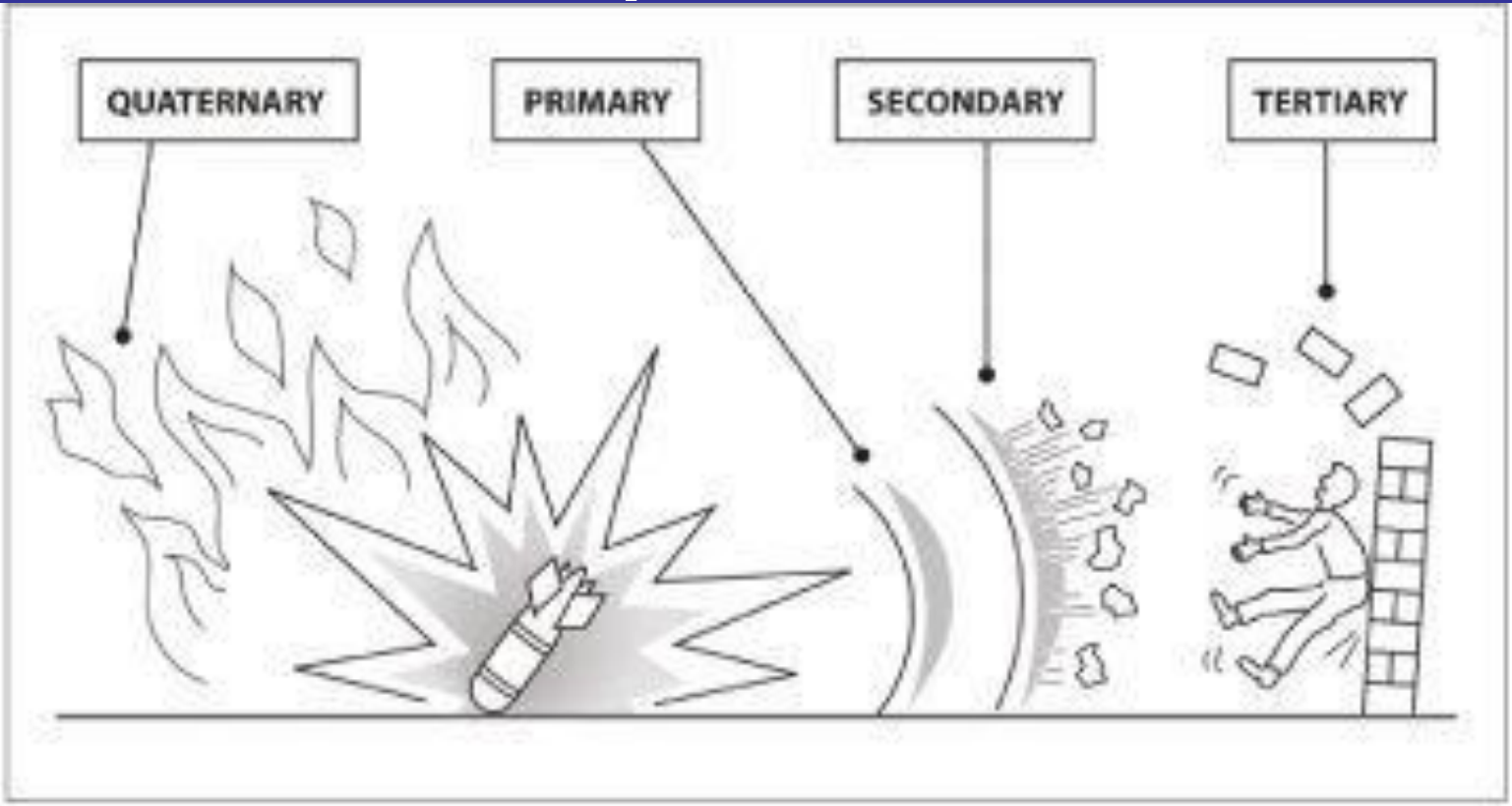
**Mechanism:**

- Contact
- Contact/deceleration
- Flexion (unrestrained)
- Hyperextension (unrestrained)

**Injury:**

- Corneal abrasions
- Abrasions of face, neck, and chest
- Cardiac rupture
- Cervical spine injury
- Thoracic spine fracture

# Explosion




| | |
|---|---|
| **Primary** | Damage to organs/tissue caused by the direct effect of blast overpressure (transmitted blast waves) on gas-containing structures |
| **Secondary** | Caused by the impact of flying objects striking the patient; e.g. shrapnel, debris |
| **Tertiary** | Impact of the patient striking another object when their body is thrown due to blast wind or structural collapse |
| **Quaternary** | All other injuries caused by explosions; e.g. burns, crush injuries, toxic inhalations, radiation exposure, environmental exposure, psychological impact |

https://healthmanagement.org/c/icu/issuearticle/blast-injury

# Explosion

**Table 1: Mechanisms of Blast Injury**

| Category | Characteristics | Body Part Affected | Types of Injuries |
|---|---|---|---|
| **Primary** | Unique to HE, results from the impact of the over-pressurization wave with body surfaces. | Gas filled structures are most susceptible - lungs, GI tract, and middle ear | - Blast lung (pulmonary barotrauma)<br>- TM rupture and middle ear damage<br>- Abdominal hemorrhage and perforation<br>- Globe (eye) rupture<br>- Concussion (TBI without physical signs of head injury) |
| **Secondary** | Results from flying debris and bomb fragments | Any body part may be affected | - Penetrating ballistic (fragmentation) or blunt injuries<br>-Eye penetration (can be occult) |
| **Tertiary** | Results from individuals being thrown by the blast wind | Any body part may be affected | - Fracture and traumatic amputation<br>- Closed and open brain injury |
| **Quaternary** | - All explosion-related injuries, illnesses, or diseases not due to primary, secondary, or tertiary mechanisms.<br>- Includes exacerbation or complications of existing conditions. | Any body part may be affected | - Burns (flash, partial, and full thickness)<br>- Crush injuries<br>- Closed and open brain injury<br>- Asthma, COPD, or other breathing problems from dust, smoke, or toxic fumes<br>- Angina<br>- Hyperglycemia, hypertension |

www.cdc.gov

# ATLS approach

Primary survey

– Airway with c-spine control

– Breathing and ventilator support

– Circulation with haemorrhage control

– Disabilty neurological support

– Exposure

Secondary survey

– AMPLE history

– Head to toe examination

- **Identify immediate life threatening injuries**
- **Resuscitation**
- **Adjuncts**
- **Re-evaluate**

# Bring it on…