Mechanisms of Trauma

VEHICULAR IMPACT

LATERAL IMPACT
- One-sided rib fractures, spleen or liver injury, hip fractures on that side
- Head acts as a mass that rotates and bends laterally – torso is accelerated away from the collision

REAR IMPACT
- Hyperextension injuries of the neck
- Posterior elements of the cervical spine get fractured
- Fractures at multiple levels are common

QUARTER-PANEL IMPACT: mixture of frontal and lateral or rear and lateral impacts

ROLLOVER
- Violent multiple movements which hurt unrestrained passengers more
- Skin injuries point to areas of impact

EJECTION
- Likelihood of serious injuries is increased 300%

COLLISION-RELATED ORGAN INJURIES

COMPRESSION INJURY
- Blunt myocardial injury
- Pneumothorax, lung contusion as it is instinctive to take a deep breath and hold it, for a patient involved in a crash. Thus, the lungs are full of air and relatively rigid.
- Diaphragmatic rupture due to sudden compression of the abdominal cavity leading to an increased intra-abdominal pressure

DECELERATION INJURY
- Aortic rupture as the aortic arch separates from the descending aorta
- Renal pedicle tear as the kidney keeps travelling and the torso stops
- Central hepatic laceration - liver accelerates around the ligamentum teres, the right and left lobes
- Subdural as the brain separates from the posterior dura
- C-spine tends to fracture at C7-T1

RESTRAINT USE
- 3-POINT RESTRAINTS DECREASE MORTALITY BY 65-70%
  - 10-fold reduction in serious injury
  - The inertial device works within 0.01sec = driver only moves 15cm
- AIRBAGS ARE ONLY USEFUL IN 70% OF IMPACTS
  - Only useful in frontal impacts, and only in the first impact
- INAPPROPRIATE USE:
  - The seatbelt has to be above the anterior superior iliac spine
  - If its above the ASIS, you will rupture your abdominal organs
  - The L-spine can suffer a compression fracture due to hyperflexion around a lap belt

Summarized from GMP medical school lectures and the ATLS handbook - many parts were treated unfairly briefly, or were entirely omitted - I strongly recommend you read the actual ATLS manual, and attend their excellent course.
PEDESTRIAN INJURIES
- 90% OCCUR AT SPEEDS BELOW 30KPH
- CHILDREN ARE THE MOST FREQUENTLY HIT PEDESTRIANS
- MOST COMMON INJURIES:
  - Thorax (most common)
  - Head
  - Lower Limbs
THREE PHASES OF PEDESTRIAN IMPACT:
- FIRST YOU HIT THE BUMPER → LOWER LIMB INJURY
- THEN YOU HIT THE HOOD AND WINDSHIELD → HEAD AND TORSO INJURY
- THEN YOU HIT THE ROAD SURFACE → HEAD, SPINE AND EXTREMITY INJURY

CYCLIST INJURIES
- PROTECTIVE CLOTHES OCCASIONALLY HELP; but:
  - Only the helmet does anything
  - No evidence that it increases the risk of neck injuries

FALLS
- THESE ARE EFFECTIVELY DECELERATION INJURIES
  - The more surface area is fallen on, the less the injury
  - If the impact is attenuated by a soft surface or a fall is broken into a series of falls, there is less injury
  - Force is transmitted. Organs will tear free from their anchoring.

BLAST INJURIES
- Two phases:
  - First, an outwardly expanding wall of gas hits you (Very brief duration)
  - Then, the negative pressure created by the first wave sucks at you (longer duration)
  - The force of the blast wave decreases in proportion to the third power of the distance
Classified into 4 tiers of injury
- PRIMARY
  - Pressure wave injury
  - Most damage is to GAS-CONTAINING ORGANS
  - Tympanic membrane is the MOST VULNERABLE: can only tolerate 2 atmospheres
  - Lung contusion, edema, rupture – may lead to air embolism
  - Intraocular hemorrhage, retinal detachment
  - Intestinal rupture
- SECONDARY
  - Flying objects striking the individual
- TERTIARY
  - The patient has become a missile and strikes other stationary objects
- QUARTERNARY
  - Burn injury
  - Crush injury
  - Dust inhalation
  - Toxic fumes inhalation

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PENETRATING INJURIES

- Low energy: knife or hand-thrown weapons
- Medium energy: handguns
- High energy: military or hunting rifles

THE WOUNDING CAPABILITY OF A MISSILE INCREASES SHARPLY ABOVE 600 METRES PER SECOND. At this velocity, a temporary cavity is created by tissue being compressed around the area of the impact.

CAVITATION:
- proportional to the surface area of the point of impact
- proportional to the density of the tissue
- proportional to velocity of projectile

Diameter of the cavity can be up to 30 times the diameter of the bullet

HOLLOW POINT ROUNDS = more rapid deceleration = more rapid energy transfer, thus more damage

YAW: the orientation of the long axis of the bullet

SHOTGUN WOUNDS
- muzzle velocity is 360 m/sec
- at 40 metres, the pellets deposit in a 75cm diameter circle
- injuries at long range are superficial
- pellets can carry clothing deep into the wound and cause infection

MISSILES FOLLOW THE PATH OF LEAST RESISTANCE. THIS PATH IS NOT ALWAYS LINEAR.