# Road Traffic Accidents (Transportation injuries)

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## Aims and objective

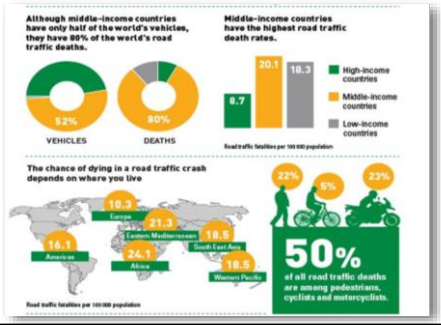
To have understanding, of injury pattern, method of causation and prevention of injuries, skills of examination and forming opinions to the court of law in

(a) Pedestrian-A
(b) Driver, front seat passenger, occupant-A
(c) Motorcyclist/ Pillion Rider/ Pedal cycler-A
(d) Investigation in a case of 'Hit and Run' -A
(e) Investigation of body found on or by the rail tract. (Accidental, suicidal, homicidal or postmortem disposal)-B

(A) Comprehensive knowledge of specified area and competency in specified medico- legal work
(B) Knowledge of the basic principles with ability to identify where referral is needed
(C) Nice to know

To produce a graduate who will be able to examine and describe injury patterns in alleged cases of RTA of both living and the dead and form opinions in a court of law as well as participate in prevention of RTA

Knowledge, skills and attitudes

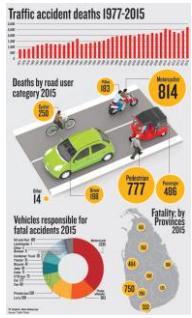




## 'Vulnerable road user' & Sri Lankan road user"

## Sri Lankan situation

- Road fatalities has been fluctuating around 2300-2500 for past few years and then show a upward trend
- In 2016: 3003 deaths
- Fatal accidents in 2016: 2824

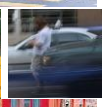
- 150 accidents are reported daily
- loss of 5-6 lives daily
  - pedestrian fatalities 33%
  - drivers and riders 41%




## The causes of RTA

- Human factors
  - Pedestrian
  - Driver/rider
- Road factors
- Vehicle factors











Most of the road traffic crashes are predictable and thus are preventable.

## The dynamics of vehicle injuries

- Tissue injury is caused by a change of rate of the movement
- A constant speed, however rapid, has no effect.
- It is the change of rate
  - acceleration
  - deceleration.
- Change of rate is measured in 'gravities' or 'G forces'.
- The amount that a human body can tolerate depends on the direction and the type of tissues in which the force acts.

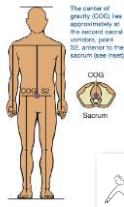
Knight' Forensic Pathology 2004

## Pedestrian injuries

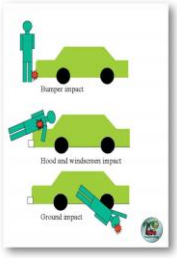

## Factors influencing pedestrian injuries

| Vehicle | Victim | Road |
|---|---|---|
| • Type of vehicle (car, lorry, bus, motor cycle)<br>• Height of the vehicle<br>• Region of the impact of the vehicle (front, rear, sides)<br>• Speed of the vehicle<br>• Behavior of the vehicle | • Height of the victim<br>• Region of the impact of the victim<br>• Center of the gravity<br>• Stationary/ moving (standing, walking, running)<br>• Movements of the victim after impact<br>• Alcohol taken by victim<br>• Hearing and vision of the victim | • Nature of the road surface (wet, slippery, bumps, projections)<br>• Objects on the road (lamp post, etc)<br>• Moving objects on the road<br>• Lighting of the road |

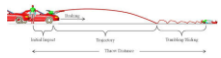
## Dynamics of the impact



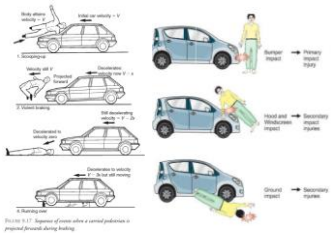

If the impact is above the COG the victim is thrown forwards while impact is below the COG the victim is scooped up




## INJURY PATTERNS



1. Primary impact injuries (vehicle)
2. Secondary impact injuries ( vehicle)
3. Secondary injuries (Tertiary impact Injuries) (ground)



## Primary impact injuries

- These injuries are caused by the vehicle when the pedestrian
  - is crossing
  - is walking with or against traffic

- The first impact with the vehicle
  - Which part of the vehicle was impacted
  - Bumper, Side mirrors (wings), grill, head lights, fender, radiator, door handle

- The primary impact may leave a the design or the pattern of the part of the vehicle as an imprint abrasion or pattern bruise

Head lamp ring

Bumper bar striking the leg

## Primary impact injuries

Can be abrasions, imprint abrasions, contusions, lacerations, muscle contusions and lacerations

## Bumper injuries

- Due to impact with the bumper of the vehicle injuries are seen in lower limbs
- Severe impact causes wedge fractures of the tibia (adults)
- The base of the wedge indicate site of impact and the apex, the direction of the travel

- Measuring the height of the injury is important in interpretation
- Some times bumper fracture occur at a lower level than the height of the bumper ( due to applying breaks)
- bumper fractures occur (14 mph)
- Multiple bumper fractures (25 mph)
- Bumper injuries at different level of two legs or presence of it in one leg indicate person is walking/ running
- Bumper injuries at same level of both legs indicate standing
- Child my sustain a bumper fracture in the femur

## Secondary impact injuries

- Victim hitting on some other part of the vehicle after the initial impact
- The injury pattern depends on
  - Type of vehicle (bonnet or flat)
  - Speed
  - Breaking
  - Projections of the vehicle
  -
- Secondary impact injuries are seen in head, chest and upper limbs

## Secondary injuries (Tertiary impact injuries)

- Injuries sustained by the victim on hitting the surface on the road, any projections or any erection on the road such as lamp post
- Common injuries are
  - Abrasions (grazed abrasions)
  - Contusions
  - Lacerations
  - Fractures
  - Head injuries
  - Internal injuries
- After secondary injuries victims may be subjected to run over injuries by same or other vehicles

## Run Over injuries

- Run over injuries are severe injuries (crushing effect)
- Weight of the vehicle moves over the body 'flaying' injury, where a rotating motor wheel tears the skin and muscle from a limb or head.
- The rotatory effect against a fixed limb may strip off almost all tissue down to the bone.
- Run over injuries are
  - Crush lacerations (de-gloving)
  - Crush fractures
  - Severe internal injuries
  - Tyre mark on clothing or skin

## Run under injuries

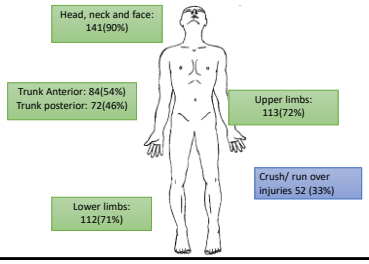
- The body gets pinned between the undercarriage of the vehicle and the hard surface of the road
- Oil and grease marks may be seen on the clothing and skin surface

## Drag injuries

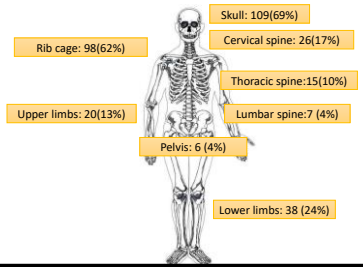
- When the victim get entangled with the vehicle and be dragged along the roard by the vehicle.
- The injuries are large areas of grazed abrasions with mud and dirt from the road



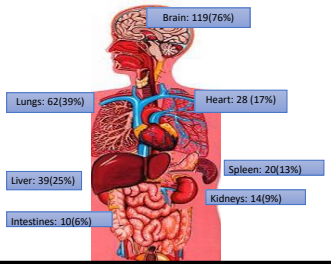
## Injuries: Injury distribution ( A study from Ragama 157 deaths

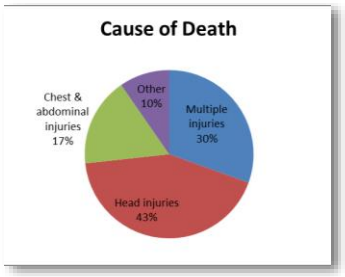



## Injuries: Skeletal injuries




## Injuries: Visceral injuries




## Pedestrians injuries with run over injuries

- SR 4536 RTA Pedestrian.docx
- SR 1670- 2009.doc
- SR 5692 RTA.docx
- SR 1728-2009 RTA Cinnaya Nadeshan.docx
- SR 3537. 2011 RTA Maj.docx

# Motorcycle/ Peddle Cycle Accident Rider / Pillion Rider

Two-wheel vehicle riders/pillion riders are categorized as vulnerable road users due to absence of an outside protective shield to absorb energy during a collision.[1]

- Their inherent instability make them more vulnerable to accidents.
- In 2004, Peden M. [1] has stated that the risk of dying for every kilometer travelled from a motorcycle crash is 20 times higher than from a motor vehicle crash.

Being the favoured vehicle among commoners, motorcycles and bicycles are a popular means of transport in Sri Lanka and at times it is the family vehicle of the middle class. In Asian countries, it is not an uncommon site to see 3 or 4 members of the same family riding on a bicycle.

| Vehicle Type | Fatal | Critical |
|---|---|---|
| Motor Cycles | 1227 | 1178 |
| Lorry | 357 | 341 |
| Dual Purpose Vehicles | | |
| Private Buses | 167 | 155 |
| Three-Wheelers | 405 | 372 |
| SLTB Buses | 50 | 50 |
| Motor Cars | 225 | 206 |
| Cycles | 48 | 48 |

## Motor Cycle accidents in Sri Lanka Police Statistics

- 2006-2010 : Total number of accidents reported 50,000-60,000 (2010)
  - Motor cycle/ Moped: 11,000-16,000
  - Car: 8,000-10,000
  - Dual purpose vehicles: 8,000-10,000
  - Lorry: 6,000-7,000
  - Three-wheeler 5,000-7,000
  - Private bus: 4,000-5,000
  - Cycle: 3,000
  - SLTB Bus: 1,500

| Vehicle Type | Fatal | Critical |
|---|---|---|
| Motor Cycles | 1227 | 1178 |
| Lorry | 357 | 341 |
| Dual Purpose Vehicles | | |
| Private Buses | 167 | 155 |
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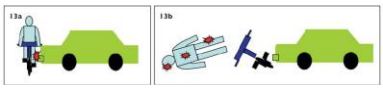
National transport commission 2015

## Rider injuries



- Frontal or side impact with a moving vehicle Hitting a stationary object
- Because of the instability usually thrown forward and upward and land on the ground
- If the speed is high secondary impact with same or another vehicle and may be run over by same or another vehicle
- Components of bicycle itself may cause injuries

## Rider injuries

## Common injuries

- Head injuries (skull and brain) temporo-parietal.
- A common complication is a basal skull fracture, especially a 'hinge' fracture. (The motorcyclist' s fracture)
- This transverse crack across the floor of the skull, crossing the petrous base or behind the greater wing of the sphenoid bones through the pituitary fossa to the opposite side

## Ring fracture

ring fracture around the foramen magnum in the posterior fossa caused by an impact on the crown of the head.

- Cerebral contusions, lacerations, brain tissue to extrude through compound fractures of the skull. SAH
- Brain damage may be severe, even with a helmet in place.
- Cervical fractures
- lower limb injuries (fractures, contusions lacerations, abrasions, burns) (direct impact or due to crash bars)
- Chest and abdominal injuries are less compared to pedestrian

- Genital injuries and perineal tears with dislocation of pubic symphysis (due to wide separation of thighs as he straddles over the seat



## Post-mortem reports of motor cycle riders

- SR 3951.2012 multiple injuries RTA [tox].docx
- SR 5337 RTA.docx

## Pillion Rider

## Pillion rider

- Unlike the rider pillion rider has noting to hold on except the rider and small holing bar
- Pillion riders are usually thrown upwards and forward any may impact on the vehicle or run over by others
- The clothing get entangle with the machine and fall (sari guard)
- May get burns from the silencer
- Injuries pattern is similar to the rider

## Postmortem reports of pillion rider

- SR 4265.2012 Head injuries pillion rider RTA 1.docx
- SR 5425 RTA.docx

## Protective gear


- Helmets
- Jackets
- Knee guard
- Gloves

# Pedal Cycle Accidents

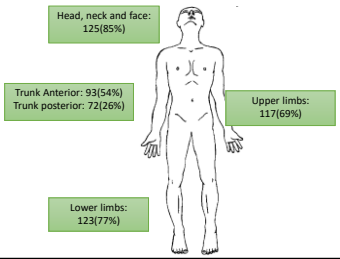
## Pedal cycle (bicycle) accidents

- Most vulnerable second to pedestrians
- Machine is unstable upon impact
- No protective gear most of the time
- Injuries depends on the speed and the impact of the offending vehicle and whether the victim was subjected to a run over
- Common injuries
  - Head injuries (falls)
  - Fractures (limbs)
  - Large grazed abrasions

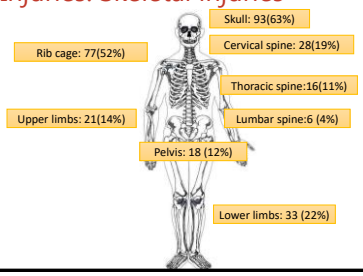
## Post mortem reports of pedal cyclists

- SR2387.10 RTA.docx
- SR4395 RTA Pedal CYCLIST.docx

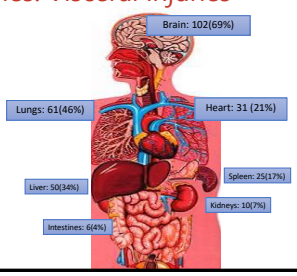
## Injury distribution of two wheel vehicles(Ragama Study 147)



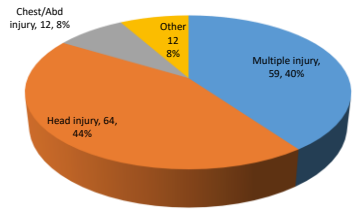

## Injuries: Skeletal injuries




## Injuries: Visceral injuries



## Cause of death…




Journal of Forensic and Legal Medicine 27 (2014) 9–12

Contents lists available at ScienceDirect

Journal of Forensic and Legal Medicine

journal homepage: www.elsevier.com/locate/jflm

ELSEVIER

Original communication

Injuries in the vulnerable road user fatalities; a study from Sri Lanka

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International Journal of Injury Control and Safety Promotion

Select Language

Translator disclaimer

A study into blood alcohol concentration in fatal accidents among vulnerable road users in a tertiary care hospital Sri Lanka

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(Received 28 June 2013; accepted 14 October 2013)

The alcohol influence among pedestrians represents a significant risk factor for fatal road traffic accidents

## Three-wheeler accidents

## Injury pattern in three wheel accident

- Accidents are due to impact with other vehicles
- Toppling is common
- Thrown out of the vehicle
- Both driver and occupants sustains injuries
- Fatalities are mainly due to head injuries
- Rear seat passenger may sustain facial and limb injuries

## Death of a three wheeler occupant

SR-3807 Head injury.docx

SR 6082 RTA.docx

## Trauma sustained by occupants of vehicles

Driver injuries
Front seat occupant
Back seat occupant

## Driver/Occupants of vehicles

- The injuries are caused by the change in rate of the movement
- Frontal impacts results in deceleration
- Rear impacts results in acceleration
- G forces acting on persons
  - G=C(V2)/D
    - (C is a Constance 0.0039
    - V is velocity in KMH
    - D is stoppage distance in meters

## Driver/ occupant injuries depend on

Moving vehicle

Collided with a train

Crashed into a static object

Nature of the impact

Head on collision

Rear collision

Side collision

Direction of the impact

Speed of the vehicles

Type of vehicle



Use of restrains



Trapped within or thrown out of vehicle



Subsequent behavior of the vehicle


## Driver injuries

## G Forces and injuries : Driver

G=.0039 V2 /D

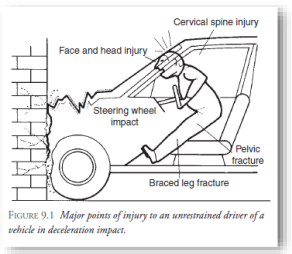



FIGURE 9.1 *Major points of injury to an unrestrained driver of a vehicle in deceleration impact.*

80 km/h
25cm penetration to wall
50cm Crumpling
33G deceleration

If restrained : the G forces can be tolerated by tissues
If no restrain: tissue injuries

## Mechanisms of injures

Head and chest impact of unrestrained driver


Whip lash injuries in in unrestrained head

Hyper-extension is the most dangerous

## Injuries to the head

- Head struck on the steering wheel, windscreen pillars, windscreen , thrown out and head struck on various objects
- Both blunt and sharp force injuries
  - Abrasions
  - Contusions
  - Lacerations
  - Cut injuries
  - Skull fractures , brain injuries , whip lash injuries
  - Cervical bone fractures

## Injuries to the face

- Can sustain both blunt and sharp force injuries
- Lacerations and cut injuries on the face
- Injuries to the eye
- Internal eye injuries

## Injuries due to head struck on the windscreen/ windscreen pillars

- Head hit on scatted windscreen small pebbled glass
- Small multiple irregular lacerations on the face
- 'sparrow foot' lacerations

## Steering wheel/ column impact

- The flexing head may hit the steering wheel
- The chest may impact on the steering wheel
  - Imprint abrasions
  - Contusions in chest wall
- Fractures of rib and internal injuries to lungs and heart (compression between sternum and the spine)
  - Cardiac contusion, haemothroax, pneumothroax
  - Lung contusions


## Steering wheel/ colum impact

- Rupture of the rectus abdominis
- Liver lacerations
- Spleen lacerations
- Mesenteric, duodenum and ileum injuries (contusions, lacerations)

Figure 1.8 *Classic appearances of a steering wheel abrasion.*

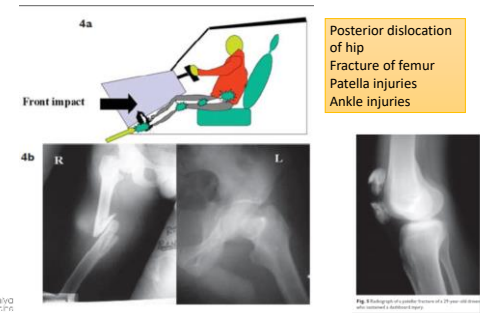
## Aorta injury

- Sudden deceleration causes rupture of the aorta (ladder tears)
- End of the arch of the aorta at which aorta is anchored to thoracic wall
- Pendulum effect of the heart

FIG 10.5 A common fatal lesion in unrestrained co occupants, following a deceleration impact. The thoracic aorta has been cleanly severed at the termination of the arch with a resulting massive haemorrhage.

## Injuries to the limbs

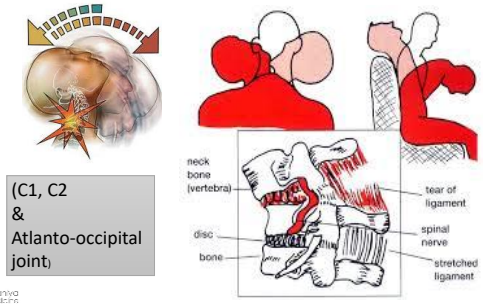
- Driver grips the steering wheel
- Forces transmitted causes injuries (fractures and dislocations ) in the upper limb
- Feet of driver on clutch, accelerator or break pedal
- Forces transmitted causes injuries in the long bones and dislocations
- Knees hit on dash board causes patella fractures



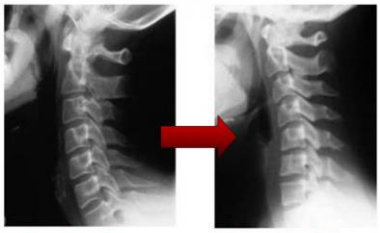

Posterior dislocation of hip
Fracture of femur
Patella injuries
Ankle injuries

## Whip lash injures

- Acute hyper-flexion followed by hyper-extension
- Injuries to spine and the cord (C1, C2 & atlanto-occipital joint)
  - Bleeding into surrounding muscle
  - Rupture of anterior longitudinal ligament
  - Tearing of intervertebral discs
  - Compression of nerve roots
  - Ischemic hemorrhage and pulping of the spinal cord




(C1, C2 & Atlanto-occipital joint)




46-year-old woman who suffered an AOD after a motor vehicle crash

CJEM 2006

- In side impact (right) the driver will have injuries on the right side of the body including cut injuries from the window glasses
- Roll over injures: projections in the cabin causes further damage
- If fire: burn injuries or even charring
- If driver is ejected 5 times greater chance of dying

## Front seat passenger injuries

## Injuries in the front seat passenger

- Front seat passenger injuries are similar to the driver except
  - No steering wheel
  - No anticipation of an accident
- Runs a risk of being thrown forwards and sustaining injuries from windscreen glass and windscreen pillars
- Ejected out of the car if not restrained

- Injuries on the face & head due to hitting on the windscreen
- Sparrow –foot injuries on face (cuts and lacerations )

- Forward movement will cause impact on the dashboard, cubby lock, door and window handle
- Abrasions/ contusions, fractures

## Similarities and differences between driver / front passengers

**Driver**

- Whip lash injuries if no head restrains
- Head injuries ( deceleration)
- Face injuries (lacerations) windscreen
- Knee, pelvic and lower limb fractures and dislocations (dash board and intrusion of engine)
- Chest injuries due to steering wheel

**Front seat passenger**

- Whip lash injuries if no head restrains
- Head injuries ( deceleration)
- Face injuries (lacerations) windscreen
- Knee, pelvic and lower limb fractures and dislocations (dash board and intrusion of engine)
- No chest injuries due to steering wheel

## Rear seat passenger

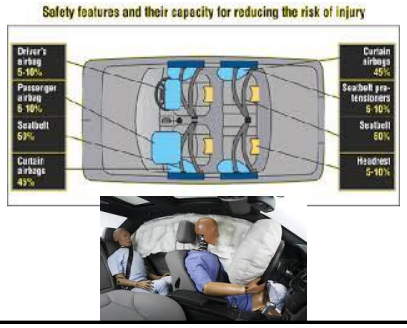
## Rear seat passenger injuries

- Severity depends on whether the passenger is restrained or not
- Thrown forwards or sideways (hit the seat in the front or sides)
- Dislocation of hips
- Fractures of limbs
- Deceleration of injuries of the head & brain
- Whip-lash injuries

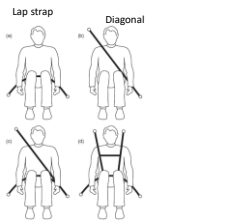
## Seat belts, air bags and head restrains are expected to reduces these injuries

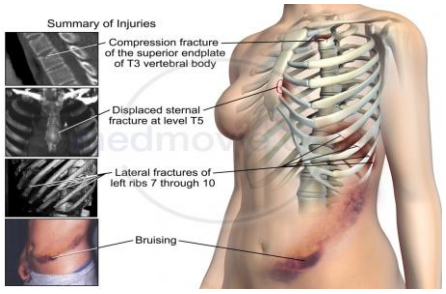
## Safety measures in vehicles to prevent/ minimize injuries

| Measure | Prevents |
|---|---|
| Windscreen : Laminated glass | severe cut injuries |
| Minimal outward projections ( bumper: fiberglass) | Reduce impact injuries in the pedestrians |
| Minimal projections within the cabin | injuries to passengers |
| Collapsible steering wheel | Injuries to head, chest and abdomen |
| Seat belt | Prevent projecting out and reduce deceleration injuries |
| Air bags (driver & passenger) | Head & chest impacts from steering wheel and dashboard |
| Curtain air bags | Reduce side impact injuries |
| Front engine and rear made up of material that absorb force and crumble and deform | Cabin space is preserved and passengers are safe |




## Injuries from seat belts




## Seat belt Injuries

- Use of seat belts have significantly reduced sustaining serious injuries especially head injuries
- They can cause
  - Clavicle injuries/ sternal injuries
  - Muscle contusion
  - Brest contusions
  - Gastrointestinal tract injuries (stomach, small bowel, colon and rectum) mesenteric lacerations
  - Lumber fractures and thoracic aorta injuries
  - Bladder injuries

Porter RS 1998, Knight 2004

## Air bag injuries

- Large fabric bag
- Placed in the steering wheel hub/ fascia in front seat passange
- Activates within milliseconds (nitrogen filled)
- Prevent the impact with fascia and hyper flexion
- It deflates also quickly

- Minor injuries to severe
- Facial bruising
- Eye injuries
  - Mild corneal laceration
  - Globe rupture
  - Orbital fracture
  - Retinal detachment
  - Chemical injuries of eye
- Tempero-mandibular joint injuries
- Shoulder and clavicle injuries
- Dislocated or fracture of arms/ amputation of fingers

Wallis, Greaves 2002

# Investigation of a case of hit and run accident

## Medico-legal investigation of 'hit & run 'accident

**History**

- When, where, and how the body was found
- Witness accounts

**Visit to the scene**

- Beak marks, trace materials from vehicle droppings
- Fragments form head lamps, windscreen fragments, paint flakes, mud guard dropping

## Identification of the victim

- Facial features
- Dental, anthropology, accessories, tattoos and marks, finger prints, DNA

## Preliminary procedure

- Photography (tyre marks, imprint abrasions)
- Collect trace materials , parts of the vehicle (glass, paint flakes, oil drips, grease, weeds dust) to compare with the suspecting vehicle

## Examination of Clothing

- Clothing for identification
- Trace material from the vehicle ( paint/grease/ oil/dust/ glass/ parts)
- Tyre marks on cloths

## General external examination

- Body stature, male/female, medical surgical interventions, features of identification, general features of disease, post mortem intervals

## Specific external examination

- Each injury in detail: regarding type, special patterns, (primary and seconary impact, secondary or run over injuries, height of occurrence, which can be compared with a suspected vehicle

## Internal examination

- All the systems for natural illness exclusion
- Internal injuries leading to death

## Special investigation

- Alcohol and drugs of abuse
- Laboratory analysis of trace materials
- Analysis of suspected vehicles and compare with trace materials found from the body and the scene

## Documentation

- PMR including COD, OPINION reconstruction of the incident, identification of the vehicle, contributory causes/ circumstances of the RTA, accident, suicide or homicide

## Postmortem report of a HIT & RUN

- SR 5555 RTA.docx


## Investigation of body found on or by the rail tract.

(Accidental, suicidal, homicidal or postmortem disposal)

## Investigation of a body recovered at or near the rail tract : The circumstances

- Accidental fall from an overcrowded train
- Accidental impact with a train at unprotected crossing
- Lightening, electrocution, snake bite
- Suicide : jumped from a train or jumped into the train or kept the head on the rail tract ( decapitation)
- Homicide : pushed from a train (fall injuries)
- Homicide: done from another method and body was taken to the trail tract to conceal injuries or as a way of disposal
- Natural: the deceased died of a sudden natural condition near or on the tract
- Possibility of intoxication/ poisoning

## The investigation

- As the hit and run injury investigation a through examination of the body is needed with a scene visit examination
- Collection of trace material both from the body and the scene
- COD including an opinion

- SR.4697 Train & Alcohol.docx

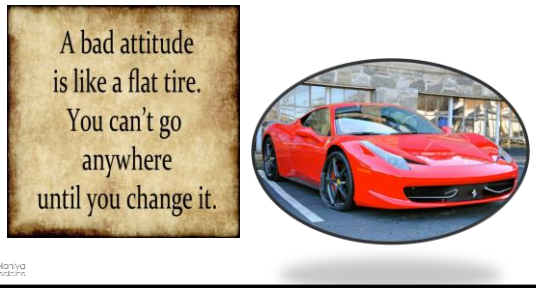
## Further reading

- Dr. LBL de Alwis -Lecture Notes in Forensic Medicine
- Transportation Injury- Pekka Saukko & Bernard Knight 3rd Edition Knight' s Forensic Pathology 2003
- Transportation Medicine Jason Payne-James, Anthony Busuttil, William Smock Eds Forensic Medicine, Clinical and Pathological Aspects 2004


- Eid H O, Abu-Zidan F M Biomechanics of road traffic collision injuries: a clinician' s perspective. Singapore Med J 2007; 48(7) : 693.
- Edirisinghe PAS, Kitulwatte IDG, Senarathne UD. Injuries in vulnerable road user fatalities; A study from Sri Lanka Journal of Forensic and Legal Medicine


## Reflect time

- Some knowledge
- Showed where to get
- Showed the skill:
  - Report writing
  - Examination of patients and conducting autopsies will be done at clinical
- Attitude to learn and serve people




ATTITUDE
IS
EVERYTHING
Thank you