



## *Injuries*

Chapters 8-10 & 14

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[Correction file](#)

## Chapter 8

# Assessment classification and documentation of injury

- ❖ One of the most important aspects of forensic medicine is the assessment, classification and documentation of injury.
- ❖ Offences against individuals of a physical nature that may result in criminal prosecutions have a great variety of types and origins, not all of which may cause visible evidence (e.g. poisoning, infection)
- ❖ The role of the forensic pathologist and forensic physician is to ensure that the medical relevance of findings, or lack of them, is understood by the investigating authority.

In the legal context, a wound is an injury that breaks the continuity of the skin. There must be a division of the whole skin structure and not merely a division of the cuticle or upper layer. As the skin is not broken, a bruise or internal rupturing of blood vessels is not a wound. A broken bone is not considered a wound, unless it is a comminuted fracture.

### Types of injury:

1. By physical force : divided into two main groups: blunt force and sharp force.
2. By non-physical forces, which can be thermal, chemical, electrical or electromagnetic

### Blunt-force injury :

Blunt-force trauma is that trauma not caused by instruments, objects or implements with cutting edges. The nature of the force applied may include blows (impacts), traction, torsion and oblique or shearing forces. May have a number of outcomes:

- no injury
- reddening
- abrasions (grazes)
- tenderness
- swelling
- lacerations
- pain
- bruising
- fracture

Both pain and tenderness are subjective findings and are thus dependent on  
(1) The pain threshold of the individual. (2) Their truthfulness.

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**Bruises** : leakage of blood into underlying tissues from damaged blood vessels. Two events must occur before a bruise can form: 1- damage to a blood vessel 2- the leakage of that blood into surrounding tissues.

Compression may produce petechiae at the level of or above the compressing force (e.g. in ligature strangulation). Bruises evolve and can 'migrate'. Gravity and tissue planes are two of the factors that may determine how the appearance of a bruise might change. Thus the presence of a bruise at a particular site does not necessarily imply that the blunt impact was applied at that site.

Age estimation based on the colour of bruising is not now considered appropriate, with one exception – a yellow-coloured bruise may be more than 18 hours old. The colouring must not be taken from photographic images where colour reproduction may be inaccurate

### **Abrasions :**

a superficial injury involving (generally) outer layers of skin without penetration of the full thickness of the epidermis.

### **Types:**

1. scratches (linear abrasions, e.g. caused by fingernails )
2. scuff (brush) abrasions (very superficial abrasions )
3. point or gouge abrasions (deeper linear abrasions caused by objects such as metal nails)
4. Crush abrasions – often associated with 'intra-dermal' bruising - are important because they may retain the pattern of the causative object.

### **Lacerations :**

Cuts, splits or tears' in the skin and are the result of a blunt force compressing or stretching the skin; they may extend through the full thickness of the skin and can bleed profusely.

- Lacerations are most common where the skin can be compressed between the applied force and underlying bone (i.e. over the scalp, face, elbows, knees, shins, etc.).
- The shape of the laceration (e.g. linear, curvilinear or stellate) rarely reflects the nature of the impacting object (unless accompanied by other patterned blunt-force injury).

## Sharp-force injury:

- ❑ Incised and slash wounds :
- ❑ caused by objects with a sharp or cutting edge, most commonly a knife. An incised injury is distinguished from a stab wound by being longer on the skin surface than it is deep.
- ❑ Incised wounds, by their nature, are only life- threatening if they penetrate deeply enough to damage a blood vessel of significant size. Thus, incised wounds over the wrist or neck, where major arteries lie in more superficial tissues, can prove fatal.
- ❑ Stab wounds:
- ❑ caused by a sharp implement and is deeper than it is long on the skin surface. For penetration of the body to occur, a variety of factors determine how much force is required, including:
  1. the sharpness of the tip of the weapon: this is often the most important factor
  2. the sharpness of the ‘cutting edge’ of the implement
  3. the nature of the force applied

## Chop injury :

caused by a variety of implements that are generally heavy, and relatively blunt, bladed instruments. These include some machetes, Samurai swords and axes.

## Other types of injury pattern:

### 1. Punching :

- ❑ A punch is a blow delivered by the clenched fist.
- ❑ Visible injury is more likely to be seen over those areas of the body where the skin is closely applied to bone, as in the face and skull.
- ❑ The entire range of blunt force injuries can be caused, including bruises, abrasions, lacerations and fractures.
- ❑ Any examination following a blow to the face or mouth requires intraoral examination.

### 2. Kicking and stamping :

The victim is often on the ground when these injuries are inflicted, and blows from the foot are commonly directed towards the head and face, the chest and the abdomen.

### 3. Bite injuries:

Bite marks can be seen in sexual assaults ( The neck, breasts and shoulders), child abuse (arms and the buttocks) a swab of the area should be taken for DNA and the bite should be photographed with a scale.

### 4. Defence injuries:

- ❑ When a knife or a stabbing implement is directed at an individual, blows to the head and face may be defended by raising the hands and arms to cover the head and face.
- ❑ Defence injuries may be absent following an assault. This may be for a number of reasons including unconsciousness from assault, or incapacity through drugs or alcohol or restraint by another person

## Survival after injury :

The length of survival following infliction of an injury is difficult to determine: every human being is different

## Self-inflicted injury :

in suicidal individuals, self-inflicted sharp-force injuries are most commonly found at specific sites on the body called 'elective sites';

incised wounds : most commonly on the front of the wrists and neck

stabbing injuries are most commonly found over the precordium and the abdomen. (Generally, the eyes, lips, nipples and genitalia tend to be spared.)

in suicidal acts, the more superficial injuries are referred to as 'hesitation' or 'tentative' injuries

The staging of assault or injury may also involve other individuals complicit in the process. In such a setting, injuries that are unusual as 'self-harm' injuries (e.g. black eyes or deep abrasions) may have been inflicted by an accomplice.

## Torture :

Specific torture techniques that may be described include:

1. Beating of the soles of the feet    amputation            electrical burns
2. Positional torture – e.g. cheera (legs stretched apart) or Parrot's Perch (wrists tied over knees)
3. Suspension, which can result in disruption of shoulder joint complexes and subsequent deformity.
4. Wet submarine – immersing the victim's head in a container full of water until the person almost drowns
5. Dry submarino – placing the victim's head inside a plastic bag until nearly suffocated.

## **Documentation of injury or marks of injury :**

### **Important point should be considered when taking history:**

- 1) Time of injury
- 2) Has injury been treated
- 3) Pre-existing illness
- 4) Regular physical activity
- 5) Regular medication
- 6) Handedness of victim & suspect
- 7) Use of drug & alcohol
- 8) Weapon used
- 9) Clothing worn

### **The following characteristics should be recorded wherever possible for each injury:**

- |                     |                          |
|---------------------|--------------------------|
| 1) Location         | 7) Shape                 |
| 2) Pain             | 8) Colour                |
| 3) Tenderness       | 9) Orientation           |
| 4) Reduced mobility | 10) Age                  |
| 5) Type             | 11) Causation            |
| 6) Size             | 12) Handedness           |
|                     | 13) Time                 |
|                     | 14) Transience of injury |

### **The recording of such information in the clinical setting should ideally be in three forms :**

- 1) Written form
- 2) Hand-drawn body diagram
- 3) Digital image



**Table 8.1** Some characteristics that may be associated with self-inflicted injury

Characteristic	Additional Comments
1. On an area of the body that the individual can access themselves	Injuries in sites less accessible (e.g. the middle of the back) are less likely to have been self-inflicted
2. Superficial or minor injury	Severe self-inflicted injuries may also be caused, particularly in those with psychiatric disorder
3. If there is more than one incised wound, they are of similar appearance, style and orientation to one another (e.g. parallel with each other)	Typically, self-inflicted sharp force injuries are more superficial, numerous and similar to each other than those sustained in an assault, where the natural reaction of the injured person is to avoid repeated injury
4. If there are other types of injury (e.g. scratches, cigarette burns) these are also of similar appearance, style and orientation to each other	As above – multiple superficial, and relatively trivial injuries that are similar in nature and extent to each other should raise the possibility of self-infliction
5. Injuries grouped in a single anatomical region	As above
6. Injuries are grouped on the contralateral side to the patient's handedness	A right-handed person will tend to harm themselves on the left side of the body
7. Tentative injuries	Smaller or lesser injuries grouped with the main injuries are termed 'tentative' or 'hesitation' marks, where initial attempts at injury have been made
8. Old healed scars in similar sites	May indicate previous attempts at self-harm
9. Scars of different ages in similar sites	May indicate repeated previous attempts at self-harm
10. Slow-healing injuries	Persistence of wounds that would otherwise have been expected to heal, in the absence of any other factors
11. Psychiatric and related issues (such as eating disorders, drug and alcohol misuse)	There may be an increased incidence of self-infliction with such conditions
12. Possibility of self-inflicted injuries created to stage a crime	These may lack many of the features referred to above.

# Chapter 9

## Regional injuries

Specific regions of the body may be particularly susceptible to types of trauma that may not cause serious or fatal injury elsewhere. A good example of this may be the single stab wound. If this penetrates the limbs then a serious or fatal outcome is unlikely, unless a large artery is injured. If a single stab wound penetrates the heart or the abdominal aorta a fatal outcome is much more likely. Consideration of patterns of injuries according to the body region, and the potential complications of those injuries, is therefore an important component in both the clinical and pathological evaluation of trauma.

### 1) Head injuries

There are three main components of the head: the scalp, the skull and the brain.

#### Scalp

- ❑ The scalp is vascular, hair-bearing skin; at its base is a thick fibrous membrane called the galea aponeurotica
- ❑ The easiest way to detect scalp injuries is by finger palpation, but shaving is often required.
- ❑ Lacerations of the scalp can usually be distinguished from incised wounds, its relative 'thinness' and tethering to the skull, contributes to the appearance of an incised wound following blunt impact.

#### Skull fractures

- ❑ the human head is divided into three main parts: the mandible, the facial skeleton and the closed container that contains the brain, the calvaria. The calvaria is made up of eight plates of bone
- ❑ The complexity of the skull structure means that mechanisms of skull fracture can be extremely complex
- ❑ The skull's capability to distort before fracturing varies with age, and an infant skull may permit significant distortion following impact without fracturing.
- ❑ Fatal brain injury can occur in the absence of externally visible scalp injury, or skull fracture and, conversely, however, intracranial injury should always be suspected in the presence of skull fracture.
- ❑ Scalp abrasions, bruises or lacerations represent contact injuries, and their presence will assist in the identification of the point of contact/impact. Bruises, however, may evolve, and 'move' in tissue planes, and may not precisely represent the site of contact/ impact by the time the scalp is examined. Abrasions to identify sites of impact



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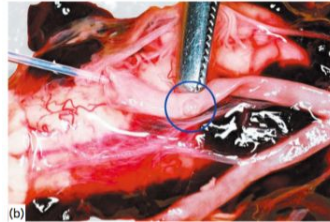
- ❑ If the vault fractures extend through the skull base from both sides, they may meet in the midline, at the pituitary fossa, and produce a complete fracture across the skull base: this is known as a hinge fracture
- ❑ significant 'broad surface' blows to the skull vault, particularly the parietal bones, may result in a 'spider's web' type of fracture composed of radiating lines transected by concentric circles.

### **Intracranial hemorrhage**

- ❑ The anatomy of the blood vessels within the skull has a major influence on the type of bleeding that will occur following trauma
- ❑ The meningeal arteries are generally protected from the shearing effect of sudden movement but are damaged by fracture lines that cross their course.
- ❑ the connecting veins are at particular risk of 'shearing' injury when there is differential movement between the brain and the skull.
- ❑ the cerebral arteries and veins, lies beneath the arachnoid membrane and is generally protected from all but penetrating injuries.
- ❑ Two main types of haemorrhage within the skull cavity are extradural and subdural haemorrhage.
- ❑ Extradural haemorrhage is associated with damage to the meningeal artery, particularly the middle meningeal artery
- ❑ Extradural haemorrhages are ones that in the clinical setting may present with head trauma and then a 'lucid period' of half an hour or more, before rapid deterioration.
- ❑ Subdural hemorrhage is associated with damage to communicating vein. This venous damage is not necessarily associated with fractures of the skull.
- ❑ Recent subdural haemorrhages are dark red in colour and shiny, but begin to turn brown after several days; microscopically, hemosiderin can be identified with Perl's stain
- ❑ The effects of both extradural and subdural haemorrhages are essentially the same, at their most severe, causing internal herniation

## Traumatic subarachnoid haemorrhage

- ❑ The vertebral arteries are confined within foramina in the lateral margins of the upper six cervical vertebrae and are susceptible to trauma either with or without fracture of the foramina.
- ❑ Most basal subarachnoid haemorrhages are, however, non-
- ❑ traumatic in origin and arise from the spontaneous rupture of a berry aneurysm

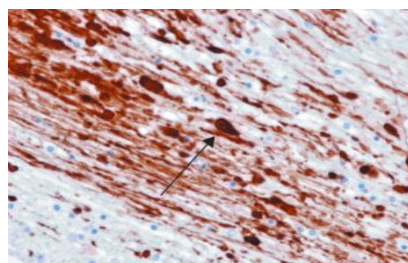


## Brain injury

- ❑ Whatever the precise cause of the trauma, the effects on the brain, as a whole, are the same and, as a consequence of the body's response to primary traumatic brain injury, cerebral oedema develops (i.e. secondary brain injury).
- ❑ Penetrating injuries from gunshots or from stab wounds can cause injuries deep within the white matter, and the tissue adjacent to the wound tracks will often be contused and lacerated.
- ❑

## Traumatic axonal injury

- ❑ Shearing is also associated with the so-called 'gliding lesions' that occur predominantly at the junction between cortical grey and white matter.
- ❑ immunohistochemical staining for  $\beta$ -amyloid precursor protein ( $\beta$ -APP) may identify injured axons, given that this stain also highlights axonal injury caused by non-traumatic phenomena including hypoxia-ischaemia
- ❑ progressive axonal injury, resulting in the formation of axonal retraction 'bulbs', can easily be recognized by silver staining techniques

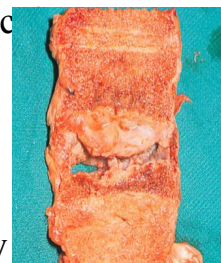


## 2) Neck injuries

- ❑ Its relevance in forensic medicine results from :
  1. the presence of a large number of vital structures
  2. It is particularly prone to injury
- ❑ The forensic post-mortem examination of the neck is done by : a Layered, dissection of the anterior (and often posterior) neck structure
- ❑ Penetrating trauma – sharp force or ballistic – to the neck : Of particular forensic significance in incised wounds to the neck is the pattern of injury :
  1. Arteria injury : suspicious death
  2. Venous injury : possibility of death caused by cardiac air embolism.

## 3) Spinal injuries

- ❑ The spine is very commonly injured in :
  1. major trauma
  2. more subtle injury, ex: disruption of the atlanto-occipital joint which can be cause damage to the upper cervical spine
- ❑ The sequelae of spinal damage will depend upon: the exact anatomic site - mechanism of injury - the type of injury
- ❑ Force applied to the spine may result in damage to the discs, the vertebral bodies, the neural arches and the transverse process
- ❑ Whiplash injuries associated with road traffic fatalities are caused by hyperextension of the neck
- ❑ hyperflexion is less likely to cause damage. Hyperflexion injuries can be caused if heavy weights are dropped onto the back of a crouching individual
- ❑ Forceful flexion of the spine will commonly lead to the ‘wedge’ fracture or compression of the anterior aspect of a vertebral body



## 4) Chest injuries

### Blunt injury

- ❑ Result in fractures of the ribs :
  1. Few: unlikely to cause effects
  2. Numerous: functional integrity of the chest wall may be compromised. Multiple rib fractures may result in the so-called “flail” chest (the area of chest around the fractures may be seen to move inwards on inspiration )
  3. Trauma that has fractured left sided 10th, 11th and 12th ribs may be substantial enough to cause injury to the underlying spleen.

- ❑ Rib fractures may have other more serious consequences based on the direction of the sharp end:

1. inward : pneumothorax, hemopneumothorax
2. Outward : pneumothoraces



- ❑ Rib fractures in children have a particular place in forensic medicine, as they can be a marker for non-accidental injury

- ❑ Rib (and sternal) fractures in adults are frequently identified at post-mortem examination following cardiopulmonary resuscitation
- ❑ microscopic examination of rib fractures identified at post-mortem examination – for evidence of ‘healing changes’

### Penetrating injuries

- ❑ The effect of the penetration will depend mainly upon which organ(s) or vessel(s) are injured.
- ❑ Haemorrhage from penetrating injuries to the chest may remain concealed with little external evidence of bleeding and it is not unusual to find several litres of blood within the chest cavity at post-mortem examination.

## 5) Abdomen

### Blunt force injury

- ❑ blunt trauma, especially in the anterior/posterior direction, may result in compression of the organs lying in the midline against the vertebral column, which in order causes injury to intra-abdominal organs, including:
  - ✓ Bruising (or even transection) of the duodenum or jejunum
  - ✓ Rupture of the pancreas
  - ✓ Rupture of the liver
  - ✓ Disruption of omentum and mesentery
- ❑ The forces required to cause these injuries in an adult must be considered to be severe and they are commonly encountered in road traffic collisions.
- ❑ kicks and stamps are commonly the cause of major trauma.
- ❑ Kidneys and spleen are susceptible to direct trauma + rotational forces that may result in avulsion from their vascular pedicles.
- ❑ Blunt trauma to the spleen is sometimes associated with delayed rupture leading to haemorrhage and possibly death some hours or even days after the injury.
- ❑ Intra- abdominal injuries could be caused by CPR but it very rare



### Penetrating injuries

- ❑ Depend almost entirely on the organs and vessels involved
- ❑ A penetrating injury to the aorta, or inferior vena cava, can result in severe haemorrhage and may produce rapid death. Peritonitis from a ruptured bowel or stomach may not be recognized until too late, by which time septicaemia will have developed.
- ❑ The presence of peritonitis and blood clots at post-mortem are both factors which may give indications of how long before death intra-abdominal trauma had occurred.

# Chapter 10

## Ballistic injuries

### Firearms

#### -Two main types of firearm:

- 1- those with smooth barrels, which fire **groups** of pellets or shot.
- 2- those with grooved or rifled barrels, which fire **single** projectiles or bullets.

- They rely upon the detonation of a solid propellant to produce the gases that propel the projectile(s).
- These two types are different than air guns and air rifles where they compressed gas to propel the projectiles.

-The speed with which the projectile leaves the end of the barrel (the muzzle velocity) varies from a few hundred metres per second to a thousand or more.

-The energy of the projectile is proportional to the speed at which it travels, so higher muzzle velocities are more effective at delivering energy to the target than larger bullets.



Watch these for more information of how do guns work

#### Gunshot injuries

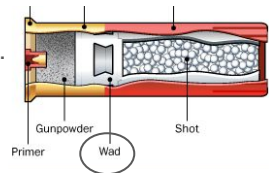
-Discharging a firearm will result in the formation of smoke, flame and gases of combustion.

-These exit the barrel with:

- 1- portions of unburned, burning and burnt propellant
- 2- other items such as wadding and plastic containers for the pellets.

-These '**contaminants**' will usually follow the projectile(s), but in some guns they may precede them.

-They can also escape from small gaps around the breech and will **soil** hands or clothing close to the breech at the time of discharge.



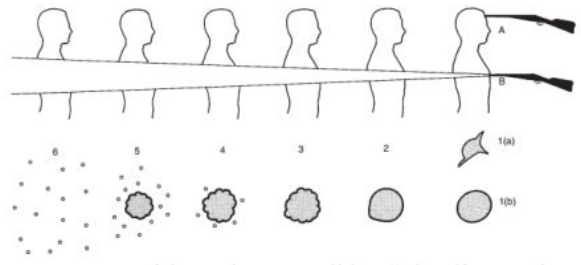
Extra: Click the picture for more information of gun parts





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### Smooth-bore guns injuries



- The shot pattern expands as a long, shallow cone with its apex close to the muzzle of the shotgun.
- The **further** away from the gun that the victim is situated, the **larger** the pellet spread, and the larger the area of potential damage.

#### **A) Contact wounds:**

- -They are created when the gun muzzle abuts (touch) the skin.
- -A **circular** entrance wound that approximates the size of the muzzle.
- -The wound edge will be regular and often has a clean-cut appearance.
- -There will be smoke soiling.
- -There may be a narrow, circular rim of abrasion around the entrance wound, caused when the gases of the discharge enter through the wound and balloon the tissues upwards so that the skin is pressed against the muzzle.
- -If the discharge was over an area supported by bone, the gases cannot disperse (distribute) as readily as they would in soft, unsupported areas such as the abdomen, and the greater ballooning of the skin results in splits of the skin, which often have a radial pattern.
- -any wadding or plastic shot containers may usually be recovered from the wound track.
- -The tissues along the wound track may be blackened and the surrounding tissues are said to be pinker than normal as a result of the carbon monoxide contained within the discharge gases.



#### **B) Close discharge:**

- -within a **few centimetres** of the surface
- -produce a wound with a similar appearance, but there is a space for muzzle gases to escape.
- -there will be **no** muzzle mark.
- -More smoke soiling can occur, and burning of skin, with singeing (burn superficially or lightly) and melted hairs around the wound.
- -There is powder 'tattooing' of the skin around the entry wound. This tattooing results from burnt and burning flakes of propellant causing tiny burns on the skin and cannot be washed off.





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### C) Intermediate range:

Satellite pellet hole      rat-hole

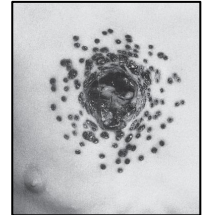


#### 1-between 20 cm and 1 m.

- diminishing smoke soiling and burning of the skin, but powder tattooing may persist.
- The **spread of shot will begin**, first causing an irregular rim to the wound. This is often called a 'rat-hole' because of the appearance of the wound edge; the term '**scalloping**' may also be used.
- Separate injuries caused by the wads or plastic shot containers may be seen.

#### 2-At a range of over 1 m.

- smoke damage and tattooing generally do not occur.
- satellite pellet holes** begin to be seen around the main central wound at a range of about 2–3 m.



### D) long ranges:

- 20–50 m.
- there is a **uniform peppering** of shot, and this is rarely fatal.



- Shotguns rarely produce an exit wound when fired into the chest or abdomen.
- Exit wounds can be seen when a shotgun is fired into the head, neck or mouth.
- In the head, where the skull may virtually explode with the gas pressure from a contact wound, ejecting part or even all of the brain from the cranial cavity.



### Wounds from rifled weapons

- rifled weapons bullets at a higher velocity than pellets from a smooth-bore weapon.
- cause both an **entry** and an **exit** wound.
- However, many bullets are retained within the body because they did not possess enough energy to complete the passage through it, or energy was expended on contact with other structures (e.g. bone).

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### Entrance and exit wounds from rifled weapons

#### **A) Contact wounds:**

- circular, unless over a bony area such as the head, where splitting caused by the propellant gas is common.
- There may be a muzzle mark on the skin surface.
- There may be slight escape of smoke, with some local burning of skin and hair, if the gun is not pressed tightly.
- Bruising around the entry wound is common.



#### **B) Close range:**

- up to about 20 cm
- smoke soiling and powder burns, and skin and hair may be burnt.
- The shape of the entry wound gives a guide to the angle that the gun made with that area of skin:
  - 1-a **circ**ular hole indicates that the discharge was at right angles to the skin
  - 2-an **oval** hole indicates a more acute angle.
- Examination of the entry wound will show that the skin is **inverted**; the defect is commonly slightly **smaller** than the diameter of the missile because of the elasticity of the skin.
- there is an '**abrasion collar**' or '**abrasion rim**' around the hole, which is caused by the friction, heating and dirt effect of the missile.

- Bruising may or may not be associated with the wound.

#### **C) Over 1 m:** no smoke soiling, burning or powder tattooing.

**D) At longer ranges:** (up to several kilometres), the entrance hole will have the same features of a round or oval defect with an abrasion collar

#### **E) At extreme ranges:** larger, more irregular wounds.



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### The exit wound

- is everted with split flaps, often resulting in a **stellate** appearance.
- No burning, smoke or powder soiling will be evident.
- If the bullet has been fragmented, or if it has fractured bone, the exit wound will be larger and more irregular, and those fragments of bullet or bone may cause multiple exit wounds.
- Where skin is firmly supported, as by a belt, tight clothing or even a person leaning against a partition wall, the exit wound may be as **small** as the entrance and may fail to show the typical eversion.
- There is a rim of abrasion..



### Air weapons, unusual projectiles and other weapons

- rely upon the force of compressed **air** to propel the projectile, usually a lead or steel pellet although darts and other projectiles may be used.
- The relatively low power of these weapons means that the pellet will seldom exit, but if it does do so, a typical exit wound with everted margins will result.



### Miscellaneous firearms and weapons

#### 1-The plastic rounds:

- In public disorder situations, for crowd control purposes.
- The purpose of these weapons is to disable and discourage rioters but **not to kill or seriously injure them**.
- They should **not** be fired at ranges less than about 20 m and should only be fired at the **lower part of the body**.
- The mark left on the skin surface by a plastic round is usually distinctive.



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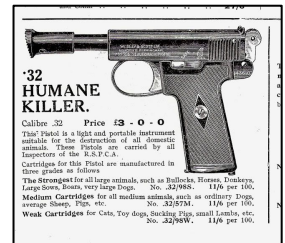
### 2-Stud guns:

- Are devices used in the building industry to fire steel pins into masonry or timber.
- They have been used for suicide and even homicide, but **accidental injuries** are more common.
- The skin injury often appears similar to many small-calibre entry wounds, although the finding of a **nail** will usually solve the diagnostic problem.



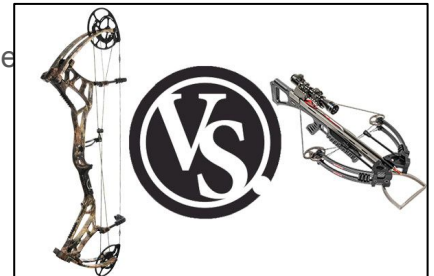
### 3-Humane killers:

- Are devices used in abattoirs (Slaughterhouse), and by **veterinary surgeons**, to stun animals before slaughter.
- These weapons have been used for both homicide and suicide, but accidental discharges are also recorded and may cause serious injury or death.



### 4-Bows and crossbows:

- Are used recreationally but may also be used as weapons of assault.
- These weapons fire arrows or bolts.
- The tips of these projectiles may have many shapes from the simple point to complex, often triangular forms.
- However, if the projectile has a simple pointed tip, and if it has been removed from the body, the entry wounds can appear very similar to those caused by standard bullets, with a central defect and surrounding abrasion rim.



## Determination of accident, suicide or murder

- Death investigators, including pathologists, must be aware of the potential for 'staging' of homicide in order to give the appearance of death having occurred as a result of accident or suicide.
- Those who have killed themselves must generally have wounds the site and range of which are **within the reach of the deceased's arm**, unless some device has been used to reach and depress the trigger.
- The weapon must be present at the scene, although it may be at a distance from the body because it may have been thrown away from the body by recoil, or by movement of the individual if death was not immediate.
- Suicidal gunshot injuries are most commonly in the '**sites of election**', which vary with the length of the weapon used.

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- -The weapons can be used in the mouth, below the chin, on the front of the neck, the centre of the forehead or, more rarely, the front of the chest over the heart.
- -Discharges into the temples are almost unique to handguns and are usually on the side of the dominant hand, but this is not an absolute rule.
- -People almost **never** shoot themselves in the eye or abdomen or in inaccessible sites such as the back.
- -It is **unusual** for females to commit suicide with guns and females are rarely involved in firearms accidents.
- -If suicide can be ruled out by the range of discharge, by absence of a weapon or by other features of the injury or the scene, a **single** gunshot injury could be either accident or homicide.
- -Multiple firearm wounds strongly suggest homicide.
- -It is most likely that severe damage to the brain, heart, aorta and any vital internal organs will lead to death; however, many forensic practitioners will have seen cases of survival following a contact discharge of a firearm into the head.

### Evidence recovery

-Any foreign objects such as wads, bullets or shot, and any skin removed from the margin of a firearm wound should be carefully **preserved for the police**.

-Those arrested for possible involvement in firearms offences will need detailed examination and taking of samples, including skin and hand swabs, and nasal samples, to identify any firearms residue.

-The same general rules apply to the post-mortem recovery of exhibits.

-The skin around the wounds may be swabbed for **powder residue** if this is considered to be necessary.

-Swabs of the hands of the victim should be taken.

-The pathologist must ensure that accurate drawings and measurements of the site, size and appearance of the wound are obtained and that distant and **close-up photographs** are taken of each injury with an **appropriate scale in view**.



## ...continue Chapter 10

### Explosives

-Armed conflict, and terrorist activity, leads to many deaths from explosive devices.

-In military bomb, shell and missile explosions, the release of energy may be so great that death and disruption from blast effects occur over a wide area.

-In contrast, terrorist devices, unless they contain very large amounts of explosive, rarely compare with military effectiveness and thus the pure blast effects are far more limited.

-However, such devices are often detonated within relatively **confined spaces** (e.g. subways and buses).

-The pure blast effects can cause either physical fragmentation or disruption of the victim or bomber solely from the effects of the wave of high pressure and hot gases striking the body.

-There will be pressure effects upon the viscera and these effects are far more damaging.

-Rupture and haemorrhage of these areas represent the classical blast lesion.

-Casualties & fatalities are caused by secondary effects of explosive devices, especially in the lower-powered terrorist bombs. These secondary effects include:

- burns
- missile injuries from parts of the bomb casing, contents or shrapnel.
- peppering by small fragments of debris and dust propelled by the explosion;
- various types of injury owing to collapse of structures as a result of the explosion.
- injuries and death from vehicular damage or destruction.

-**Post-mortem radiology** is essential, in order to identify unexploded ordinance, and items comprising components of the explosive device.

-Identification of deceased individuals is important, not only ethically, but also to enable the relevant medico-legal authority to discharge their responsibilities.

-The identity of suicide bombers, whose bodies are frequently extensively disrupted following the explosion, may be extremely challenging



## ...continue Chapter 10

### Mass disasters and the doctor

- Increasingly, such a situation is just as likely to involve a terrorist incident.
- For the non-specialist doctor at the scene of a mass disaster of any kind, the first consideration is the treatment of casualties, which may involve taking difficult ethical decisions about triage.
- The police and the usual state agencies (or Coroner) responsible for sudden death.
- All these details are recorded on standard forms and charts and the information is sent back to the identification teams, who can compare this post-mortem information with antemortem information obtained from relatives, friends.
- An internal post-mortem examination is usually performed to determine the cause of death, retrieve any foreign objects that, for example, may be related to an explosive device, and to seek any further identifying features, such as operation scars and prostheses.

### **Box 10.1** Recommended ethical principles and procedures with regard to the physician's role in disaster situations, from WMA statement 2006

1. Triage is a medical action of prioritizing treatment and management based on a rapid diagnosis and prognosis for each patient. Triage must be carried out systematically, taking into account the medical needs, medical intervention capabilities and available resources. Vital acts of reanimation may have to be carried out at the same time as triage. Triage may pose an ethical problem owing to the limited treatment resources immediately available in relation to the large number of injured persons in varying states of health.
2. Ideally, triage should be entrusted to authorized, experienced physicians or to physician teams, assisted by a competent staff.
3. The physician should separate patients into categories and then treat them in the following order, subject to national guidelines:
  - a. Patients who can be saved but whose lives are in immediate danger should be given treatment straight away or as a matter of priority within the next few hours.
  - b. Patients whose lives are not in immediate danger and who are in need of urgent but not immediate medical care should be treated next.
  - c. Injured persons requiring only minor treatment can be treated later or by relief workers.
  - d. Psychologically traumatized individuals who do not require treatment for bodily harm might need reassurance or sedation if acutely disturbed.
  - e. Patients whose condition exceeds the available therapeutic resources, who suffer from extremely severe injuries such as irradiation or burns to such an extent and degree that they cannot be saved in the specific circumstances of time and place, or complex surgical cases requiring a particularly delicate operation which would take too long, thereby obliging the physician to make a choice between them and other patients may be classified as 'beyond emergency care'.
  - f. As cases may evolve and thus change category, it is essential that the situation be regularly reassessed by the official in charge of the triage.

The following statements apply to treatment beyond emergency care:

- g. It is ethical for a physician not to persist, at all costs, in treating individuals 'beyond emergency care', thereby wasting scarce resources needed elsewhere. The decision not to treat an injured person on account of priorities dictated by the disaster situation cannot be considered a failure to come to the assistance of a person in mortal danger. It is justified when it is intended to save the maximum number of individuals. However, the physician must show such patients compassion and respect for their dignity, for example by separating them from others and administering appropriate pain relief and sedatives.
- h. The physician must act according to the needs of patients and the resources available. He/she should attempt to set an order of priorities for treatment that will save the greatest number of lives and restrict morbidity to a minimum.



## Chapter 14

# Transportation medicine

- -All forms of transport (air, water or land) are associated with a risk of harm or injury.
- -The incidence of those risks is increased when other factors are taken into account, including lack of experience, fatigue and the effects of drugs and alcohol.

### Every jurisdiction has laws that:

- 1-control the speed of the vehicles
  - 2-control the amount of alcohol and/or drugs the individual can consume
- They measure the levels of alcohol in blood, breath or urine

### 'Driving under the influence'

-In many cases it's confirmed by the ability, or failure, to pass standardized tests of sobriety(not a drunk ), or by medical examination to determine whether the ability to drive may be impaired, following preliminary impairment tests undertaken by police personnel.

-Initial screening may be done by officers at the scene of an alleged offence or accident, using '**field impairment tests**'.

-Evidential 'breath alcohol machines' are used to take breath samples, and if for some reason (e.g. asthma, oral trauma) it is not possible for an individual to provide a sample, then blood or urine samples must be sought.

-The aim of the examination in the medical assessment is to determine  
(1) whether the individual's ability to drive is impaired,  
(2) which drug/substance is causing this impairment,  
(3) whether there is a medical reason for the individual's apparently impaired status (e.g. neurological disorder, psychiatric disorder).

-certain procedures that measure psychomotor function and '**divided attention tests**' are used.

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### **Divided attention tests**

- which assess an individual's balance and coordination.
- Also assess the ability to follow simple instructions, include the 'walk and turn test', 'one-leg stand test', 'horizontal gaze nystagmus test' and Romberg test.

**Many individuals will have used a mixture of drugs and alcohol, which make the results of specific drugs groups inappropriate or wrong.**

### **Field impairment tests** ('preliminary impairment tests' in the UK)

- They are useful in screening individuals suspected of being impaired as a consequence of drug use, and provide supportive evidence of impairment.
- They cannot be used with certainty to confirm that drugs have been used, or the particular drug or drugs that may have Consumed.

### **Personal transport and road traffic injuries**

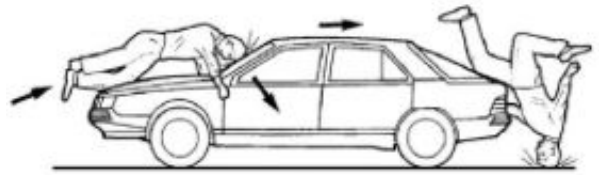
Those injured by collisions on the road, or offroad using personal transport can be divided into three broad groups:

- 1-pedestrians
- 2-cyclists (pedal or motor)
- 3-drivers or passengers of vehicles.

- Of these three broad groups, it is **pedestrians** who are most often injured
- The greater mingling of motor transport and pedestrians the greater risk of injury to the pedestrian.
- Most road deaths in the world occur in developing countries.

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### Pedestrians



#### Pedestrians struck by motor vehicles suffer injuries:

- 1-from direct contact with the vehicle (primary injuries) or
- 2-from contact with other objects, or the ground, after the primary contact with the vehicle (secondary injuries).

-When an adult is hit by the front of a car, for example, the front bumper (fender) usually strikes the victim at about **knee** level.(primary injury)

-The exact point of contact, however, whether on the front, side or back of the leg(s), will depend on

- 1-the orientation of the victim
- 2-the nature of the front of the car
- 3-whether or not it is actively braking at the time of impact.

-There are often additional primary injury sites on the thigh, hip or pelvis caused by contact with other parts of the car, such as the bonnet (the hood).

-**At low speeds 20 kph** the victim thrown off the bonnet either forwards or to one side.

-**Between 20 and 60 kph** the pedestrian may strike the bonnet (hood) and the head may strike the windscreen.

- **At higher speeds (60–100 kph)** pedestrians may be projected up into the air; sometimes they will pass completely over the vehicle and will avoid hitting the windscreen and other points on the vehicle.

-Such impacts will cause complex fractures or traumatic amputations.

-Secondary injuries are more serious and lethal.

-Such secondary injuries vary from simple '**brush abrasions**' to fractures of the skull or axial skeleton, to hyperextension or hyperflexion fractures of the spine.

-Even in the absence of skull fracture, traumatic brain damage, including traumatic axonal injury, is frequently observed in fatally injured pedestrians.

-This occurs as a consequence of the **rotational, deceleration** forces produced when the rapidly moving head is suddenly stopped at impact, leading to 'shearing' injuries to the brain and its coverings.

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- Fractures of the **spine**, especially in the cervical and thoracic segments, may lead to cord damage.
- Fractures of the **limbs** are common but, apart from those of the legs that are associated with the primary impact sites, they are somewhat unpredictable because of random 'flailing' of the limbs following primary impact.
- When an adult is struck by a larger vehicle, for example a van, truck or lorry, or when a small child is struck by any vehicle, the typical lower limb primary contact injury site described above tends to be 'higher up' (pelvis, abdomen, chest or head).
- It is likely that the victim will make contact with more of the front of the vehicle or be projected along the line of travel of the vehicle and 'run-over'.
- 'Run-over'** injuries are relatively unusual and the effects are variable, depending on 1-area of the body involved 2-vehicle weight 3-surface area of the contact.
- Compression of the chest may result in multiple rib fractures, causing a **'flail chest'**.
- The rotation of the wheel may strip off large areas of skin and subcutaneous tissue; this is called a **'flaying injury'**.
- patterned injuries are characterised as tyre-treads

### Car occupants

- -Most impacts involve the front of the vehicle and the impacts are against either another vehicle or a stationary object.
- -This type of impact rapidly **decelerates** the vehicle.
- -Less commonly, the vehicle is hit from behind, causing an **'acceleration'** impact.
- -The least common impacts are side impacts and **'roll-overs'**.
- -Unrestrained (not wearing the seat belt) front-seat occupants in a vehicle subjected to rapid deceleration during a collision will continue to move forwards as the vehicle decelerates around them, and will impact those parts of the vehicle that are in front of them.
- -The injuries of rear-seat occupants, may not severe such as the front-seat occupants.
- -In a deceleration impact, the rear-seat passengers will be thrown against the backs of the front seats and may impact the front-seat occupants.
- -They may be projected over the front seat to hit the windscreen and even be thrown out through the windscreen.

## Box 14.1 Injuries that may be expected to occur in an unrestrained impact/collision

- The face and head hit the windscreen glass, frame or side-pillars, causing skull and facial fractures, injury to the brain and its coverings, and cervical spine injury.
- The chest and abdomen contact the fascia or the steering wheel, causing rib, sternal, heart and liver injuries.
- The momentum of the heart within the thorax, perhaps aided by hyperflexion, may tear the aorta at the termination of the descending part of the arch, at the point where the vessel becomes attached to the vertebral column.
- The legs of the passenger are thrown forwards and the knees may strike the parcel shelf, causing fractures.
- The legs of the driver, which are commonly braced on the brake and clutch pedals, may transmit the force of impact along the tibia and femur to the pelvis. All of these bones may be fractured or dislocated.
- On the rebound from these impacts, the heavy head may swing violently backwards and cause injury to the cervical or thoracic spine.
- The occupants of the car may be ejected out of the vehicle through the windscreen, increasing the risks of secondary injuries or being run over by another vehicle.

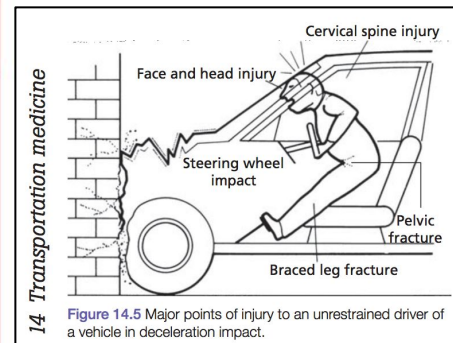


Figure 14.5 Major points of injury to an unrestrained driver of a vehicle in deceleration impact.



Figure 14.6 Facial injuries from shattered windscreen glass in an unrestrained driver. The toughened glass breaks into small fragments, which produce characteristic 'sparrow foot' marks. The forehead laceration was made by the windscreen rim.

## Box 14.2 The function of seat belts

A seat belt that is correctly installed, and worn, acts in the following ways:

- It spreads the deceleration forces at impact over the whole area of contact between the straps and the body surface so that the force delivered to the body per unit area is reduced.
- It is designed to stretch during deceleration and some belts have a specific area for this to occur. This stretching slightly extends the time of deceleration and reduces the force per unit time.
- It restrains the body during deceleration, keeping it away from the windscreen, steering wheel and other obstructions at the front of the vehicle, thus reducing injury potential.
- It prevents ejection into the road through burst doors or windows, which used to be a common cause of severe injury and death.



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### The function of seat belts

- The combination of a horizontal lap strap and diagonal shoulder strap was introduced as a satisfactory compromise between effectiveness and social acceptability. To be effective, a seat belt must
  - (1) be worn
  - (2) worn correctly.
- The use of seatbelts can also cause injuries.

### Air bags

- Air bags aid the protection of all car occupants following a collision by rapidly deploying a 'soft method of restraint' that is only present when require.
- They are designed to provide protection to the 'average-sized adult' in the front of the car.
  - Air bags can cause injuries, most frequently abrasions or burns.
  - Most cars have the option of disabling air bags if those of short stature (generally children) are occupying such seats.
  - Air bags, in general, should **never** be used in the presence of baby seats.
  - The back of the baby seat may lie within the range of the bag when it is maximally expanded, and fatalities have been recorded following relatively minor vehicle impacts when the airbag has struck the back of the baby seat.

### Motorcycle and pedal cycle injuries

- Most injuries to motorcyclists are caused by **falling** from the machine onto the roadway.
- Many of the injuries can be reduced or prevented by the wearing of suitable protective clothing and a crash helmet.
- Abrasions** caused by contact with the road surface are almost universal following an accident at speed, and injuries to the limbs and to the chest and spine occur very commonly because of contact with other objects or vehicles, entanglement with the motor bike or direct contact with the road.
- A more unique injury occurs from '**tail-gating**' (drive too closely behind (another vehicle)), where the motorcyclist drives under the rear of a truck, causing severe head injuries or even **decapitation**.
- This injury has been reduced by the presence of bars at the sides and rear of trucks to prevent both bikes and cars passing under the vehicle.
- Secondary injuries, especially to the head and chest, are common.

## *...continue Chapter 14*

### **Railway injuries**

- These are most common in countries with a large railway network, such as India and China, and in countries where rail crossings are unprotected or unmanned.
- Railway lines are a common site for **suicide** attempts.
- Medically, there is nothing specific about railway injuries except the frequency of very severe mutilation(amputation).
- The body may be severed into many pieces and soiled by axle grease and dirt from the wheels and track.
- Where passengers fall from a train at speed, multiple injuries caused by repeated impacts and rolling may be seen, often with multiple abrasions from contact with the coarse gravel of the line ballast.

### **Suicides on railways fall into two main groups:**

- 1-those that lie on the track (sometimes placing their neck across a rail so that they are beheaded)
- 2-those that jump in front of a moving train from a platform, bridge or other structure near to the track.

- they may be localized with black soiling at the crushed decapitation or amputation site if the individual has lain across the track.
- There is a risk of secondary injury if survival occurs where other factors such as electrified lines are present.
- On electrified lines, an additional cause of suicidal or accidental injury or death is present in the form of electric shock from either a live rail or overhead power lines.
- A careful search for unusual injuries inconsistent with the setting, as homicides may be concealed by staging the scene, with the deceased being placed on the rail track in an attempt to conceal the true cause of death.
- Railway workers may be injured or killed by falling under, or by being trapped between the buffers of two trucks while uncoupling or coupling the rolling stock.
- The injuries associated with the squeezing between rolling stock are often those of a flail chest, with or without evidence of traumatic asphyxia.

### **Aircraft fatalities**

#### **Aviation incidents can be divided into two main groups:**

- 1-those that involve the crew and the large numbers of passengers of a modern, commercial aircraft.
  - 2- those that involve the occupants of small, relatively slow, light aircraft.
- Large aircraft are pressurized and, if the integrity of the cabin is breached, there can be rapid decompression and the passengers may suffer **barotrauma**.
  - If the defect in the cabin is large enough, victims may exit through the defect and fall to their death.



## ...continue Chapter 14

- -When an aircraft hits the ground, the results will depend on the rapidity of transfer of the forces, and this is dependent on the speed of the aircraft and the angle of impact.
- -The usual lap-strap seat belt offers little protection in anything but the most minor accident. -Fire is one of the greatest hazards in air crashes and accounts for many deaths.
- -In light aircraft crashes, the velocity, and hence the forces, may be less than in large commercial aircraft, but they are still often fatal.
- -The investigation of air accidents is a task for specialist medical personnel, who are often available from the national air force or from a civil authority.
- -There should always be a full autopsy on the pilot or suspected pilot, with full microscopic and toxicological examination to exclude natural disease, drugs and alcohol.

### Marine fatalities

- -Fatalities in the marine setting embrace a range of marine-specific and general injury types.
- -The range of activities include commercial diving, recreational diving, use of powered water sport bikes, sailing, motor cruising and commercial marine transport (e.g. oil tankers, container ships, passenger vessels).
- -The likelihood of dying in a marine environment is enhanced by **not** wearing appropriate safety gear.
- -In the recreational setting, fatalities occur when individuals fall from vessels and drown, or succumb to hypothermia, or cannot be recovered back on board.
- -Physical injuries in recreational sailing are widespread and examples include those of suffering direct trauma, loss of digits or limbs when caught up in winches or anchor cable, limb fractures or skull fractures from direct impact from flailing blocks and burn injury from uncontrolled rope movement.
- -**Drowning** may occur from being trapped after inversion of the vessel.
- -**Motor-powered vessels** may cause injury from explosion or fire, or those in the water may sustain injury from rotating propellers.
- -**Commercial vessels** may cause their own specific problems, such as asphyxiation in storage tanks or falls from heights.
- -Most of these scenarios are of an industrial/occupational nature and may involve potential breaches of health and safety legislation.