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CHAPTER (1): PRINCIPLES OF FORENSIC PRACTICE

- In KSA the system used is coroner system which is “The Bureau of Investigation and Public Prosecution” i.e. هيئة الإيداع والتحقيق العام.

Legal systems:

- Most countries have two main legal systems:
 1. **Criminal courts:** deals predominantly with disputes between the State and individual.
 2. **Civil courts:** deals with disputes between individual including those of alleged negligence, contractual failure, debt, and libel or slander.
- Decisions made by judges are referred to as ‘common law’ or ‘case law’.

Criminal law:

- Criminal law deals with relationships between the state and the individual and as such is probably the area in which forensic medical expertise is most commonly required.
- Criminal trials involve offences are ‘against public interest’; these include offences against the person (e.g. murder, assault, grievous bodily harm, rape), property (e.g. burglary, theft, robbery), and public safety and security of the state (terrorism).
- Prosecutions for crime in England and Wales are made by the Crown Prosecution Service (CPS), who assess the evidence provided to them by the police.
- The more serious the offence or the offender’s record of criminal behaviour, the more likely it is that a prosecution will be required in the public interest.
- The penalties that can be imposed in the criminal system commonly include financial (fines), imprisonment and community-based sentences. Some countries allow for corporal punishment (beatings), mutilation (amputation of parts of the body) and capital punishment (execution).
- Special courts are utilised for those under 18 years of age.

In both civil and criminal trials, the person against whom the action is being taken is called the **defendant**; the accuser in criminal trials is the state and in civil trials it is the **plaintiff**.

- **Professional witness:** A professional witness is one who gives factual evidence. This role is equivalent to a simple witness of an event, but occurs when the doctor is providing factual medical evidence.
 - **Expert witness:** An expert witness is one who expresses an opinion about medical facts. An expert will form an opinion, for instance about the cause of the fractured leg or the laceration.
 - The role of an expert witness should be to give impartial and unbiased assessment or interpretation of the evidence that they have been asked to consider.
 - The duties of an expert are summarized as being that the expert's duty is to the court and any opinion expressed must not be influenced by the person who requested it, or by whoever is funding it, but must be impartial, taking into account all the evidence, supporting it where possible with established scientific or medical research, and experts should revise the opinion if further or changed evidence becomes available.
- ❖ **key elements to expert evidence:**
1. Expert evidence presented to the court should be, and should be seen to be, the independent product of the expert uninfluenced as to form or content by the exigencies of litigation.
 2. An expert witness should provide independent assistance to the Court by way of objective, unbiased opinion in relation to matters within his expertise.
 3. An expert witness in the High Court should never assume the role of an advocate.
 4. An expert should state facts or assumptions upon which his opinion is based.
 5. He should not omit to consider material facts which could detract from his concluded opinion.
 6. An expert witness should make it clear when a particular question or issue falls outside his area of expertise.
 7. If an expert's opinion is not properly researched because he considers that insufficient data is available, then this must be stated with an indication that the opinion is no more than a provisional one.
 8. In cases where an expert witness, who has prepared a report, could not assert that the report contained the truth, the whole truth and nothing but the truth without some qualification, that qualification should be stated in the report.
 9. If, after exchange of reports, an expert witness changes his views on a material matter having read the other side's report or for any other reason, such change of view should be communicated (through legal representatives) to the other side without delay and when appropriate to the court.
 10. Where expert evidence refers to photographs, plans, calculations, analyses, measurements, survey reports or other similar documents, these must be provided to the opposite party at the same time at the exchange of reports.

Evidence for courts:

❖ Statements and reports

- A statement in a criminal case is a report that is prepared in a particular form so that it can be used as evidence.
- A statement provided when acting as a professional witness will be based on the contemporaneous notes (notes or records made at the time of examination), and it is important that the statement fairly reflects what was seen or done at the time.
- A statement may be accepted by both defence and prosecution, negating the need for court attendance.

❖ **Attending court:** If a citizen is asked to appear as a witness for the court, it is the duty of all to comply.

❖ The process of giving evidence:

- Whether called as a witness of fact, a professional witness of fact or an expert witness, the process of giving evidence is the same.
- When called into court, every witness will, almost invariably, undergo some formality to ensure that they tell the truth. Regardless of how it is done, the effect of the words is the same: once the oath has been taken, the witness is liable for the penalties of perjury.
- Whoever has 'called' the witness will be the first to examine them under oath; this is called the 'examination in chief' and the witness will be asked to confirm the truth of the facts in their statement(s).
- When this questioning is completed, the other lawyers will have the opportunity to question the witness; this is commonly called 'cross-examination'. This questioning will test the evidence that has been given.
- The final part of giving evidence is the 'reexamination'. Here, the original lawyer has the opportunity to clarify anything that has been raised in cross-examination but he cannot introduce new topics.

Doctors in court:

❖ Preparation of medical reports

- A report may be requested by the police, prosecutors, Coroners, judges, medical administrators, government departments, city authorities or lawyers of all types.
- A good rule of thumb is to ensure that, when medical records will need to be reviewed, written permission to access and use those records has been given, either by the individual themselves, or by an individual or body with the power to give that consent.

- The fact of a request, even from a court, does not mean that a doctor can necessarily ignore the rules of medical confidentiality.
- Mandatory reporting of medical issues may be relevant in some countries; often these relate to terrorism, child abuse, use of a weapon and other violent crime.

❖ Structure of a statement or report:

- The basis of most reports and statements lies in the contemporaneous notes made at the time of an examination
- A simple professional witness statement, Included may be the doctor's professional address and qualifications should follow. The date of the report is essential and the time(s), date(s) and place(s) of any examination(s) should be listed, as should the details of any other person who was present during the examination(s).
- Medical abbreviations should be used with care and highly technical terms, especially those relating to complex pieces of equipment or techniques, should be explained in simple, but not condescending, terms.
- Autopsy reports are a specialist type of report and may be commissioned by the Coroner, the police or any other legally competent person or body. An autopsy report is confidential and should only be disclosed to the legal authority who commissioned the examination.
- Doctors must resist any attempt to change or delete any parts of their report by lawyers who may feel those parts are detrimental to their case; any requests to rewrite and resubmit a report with alterations for these reasons should be refused.

CHAPTER (2): THE ETHICS OF MEDICAL PRACTICE

- The principles of medical ethics have developed over several thousand years and continue to evolve and change, influenced by society, the legal profession and the medical profession itself.
- The laws governing the practice of medicine vary from country to country, but the broad principles of medical ethics are universal and are formulated not only by national medical associations, but organizations such as the World Medical Association (WMA).

Duties of a physician as defined by the World Medical Association:

1. Respect a competent patient's right to accept or refuse treatment.
 2. Deal honestly with patients and colleagues.
 3. Not receive any financial benefits or other incentives solely for referring patients or prescribing specific products.
 4. Behave towards colleagues as he/she would have them behave towards him/her.
 5. Provide a high standard of practice and care at all times.
- As a professional, you are personally accountable for actions and omissions in your practice, and must always be able to justify your decisions.

Medical ethics in practice:

- ❖ Patient autonomy and their right to refuse or choose treatment.
 - ❖ Non-maleficence - do no harm.
 - ❖ Beneficence - acting in the patient's best interests.
 - ❖ Dignity.
 - ❖ Honesty - providing informed consent.
 - ❖ Justice - how healthcare is apportioned when.
 - ❖ Health and financial resources may be limited.
- The key to a doctor-patient relationship is trust. If patients are not assured about confidentiality then they may be put off seeking medical attention or providing doctors with the right information to ensure they get optimal care.

When confidentiality may not apply?

1. If required by law.
2. Reporting serious communicable diseases.
3. Reporting concerns about driving capabilities.

Consent:

- Consent is a key concept of healthcare and it is expected that all decisions about treatment and healthcare come about as a result of collaboration between doctors and patients. Consent should be based on trust, openness and good communication.
- Age is not a rigid factor in ability to consent, although it is generally accepted that those aged 16 years and older have the capacity to make decisions about treatment or care.
- If patients are unable to make decisions for them selves, the doctor must engage with those who are close to the patient and with colleagues involved in the healthcare.

CHAPTER (3): THE MEDICAL ASPECTS OF DEATH

Definition of death:

- It is a process in which cellular metabolic processes in different tissues and organs cease to function at different rates.
- It Has two separate aspects :
 1. (Cellular death): death of a single cell.
 2. (Somatic death): the cessation of the integrated functioning of an individual.

1- Cellular death:

- Cellular death means the cessation of respiration and the normal metabolic activity in the body tissues and cells followed by autolysis and decay.
- The differences in cellular metabolism determine when cells die:
 1. Skin and bone = die days after somatic death.
 2. White blood cells = 12 hours after cardiac arrest.
 3. The cortical neuron= 3-7 minutes.

2- Somatic death and resuscitation:

- The individual is irreversibly unconscious.
- The Academy of Medical Royal Colleges has published a code of practice for the diagnosis of death.
- Criteria for the diagnosis and confirmation of death following:

1- Cardiorespiratory arrest:

- Irreversible onset of apnoea.
- One of the following applies:
 - Not attempting (CPR) are fulfilled.
 - CPR failed.
 - Life-sustaining treatment has been withdrawn.
- Absence of a central pulse and heart sounds for 5min.
- Asystole on (ECG), absence of contractile activity or pulsatile flow.
- Absence of pupillary responses, corneal reflexes and any motor response to supra-orbital pressure.
- The time of death is recorded when these criteria have been fulfilled.

2- Irreversible cessation of brain-stem function:

- Absence of brain-stem reflexes.
- Brain-stem testing should be made by at least two medical practitioners, one of these must be a consultant.
- Ancillary investigations when there are extensive maxillofacial injuries.
- Irreversible brain damage resulting from damage of known aetiology or, no possibility of a reversible or treatable underlying cause.
- Causes of coma, depressant drugs, Hypothermia, reversible circulatory, metabolic and endocrine disturbances, and reversible causes of apnoea (neuromuscular blocking agents) have been excluded.

Vegetative state:

- Brain-stem functioning in the absence of cortical function.
- It may recover, or alternatively may enter a ‘minimally conscious state’ (MCS).
- If the VS persists for 12 months following traumatic brain injury or 6 months after another cause, the VS is judged to be ‘permanent’. In such circumstances, he withdrawal of hydration and assisted nutrition can be considered in the ‘best interests’ of the patient.

Tissue and organ transplantation:

- The laws relating to tissue and organ donation and transplantation are dependent upon the religious and ethical views of the country. Transplantation is expressly forbidden in Jehovah’s Witnesses.
- The organs and tissues to be transplanted may come from one of several sources, which are outlined below:

1- **Homologous transplantation:** Tissue is moved between sites on the same body. For example, skin grafts, bone chips.

2- **Live donation:** In this process, tissue is taken from a living donor whose tissues have been matched to, or are compatible with, those of the recipient. The most common example is, blood transfusion, marrow transplantation, kidneys or transplantation of a part of a single organ (such as the liver).

3- Cadaveric donation:

- The best results are still obtained if the organs are obtained while circulation is present or immediately after cessation of the circulation. The aim is to minimize the ‘warm ischaemic time’. Some organs (e.g. kidneys) are more resilient to anoxia than others and can survive up to 30 minutes after cessation of cardiac activity.

- ‘Opting in’ system: the transplant team must ensure that the donor either gave active permission during life or at least did not object and that no close relative objects after death.
 - If an autopsy will be required by law for any reason, the permission must be obtained before harvesting of tissue or organs is undertaken.
- 4- **Xenografts:** It is Grafting of animal tissue into humans. There is considerable difficulty with cross-matching the tissues and possibility of transfer of animal viruses to an immunocompromised human host.
- 5- **Cloning:** A cheaper solution involves the cloning of animals for use as transplant donors.

Cause of death determination and certification:

- In general, if a doctor knows the cause of death, and that cause of death is ‘natural’, they may issue a ‘death certificate’.
- The format for certifying the cause of death is now defined by (WHO). The system divides the cause of death into two parts:

Part I: describes the condition(s) that led directly to death; divided into three subsections (a), (b) and (c). These are for disease processes: (a) being caused by or is a consequence of (b). (b) in turn is caused by or is a consequence of (c), etc. The disease lowest in the Part I list is the most important, as it is the primary pathological condition in the leading to death. Also, it is used to compile mortality statistics.

Examples:

- 1- Ia Cardiac failure / Ib Hypertrophic cardiomyopathy.
- 2- Ia Coma / Ib Subarachnoid haemorrhage / Ic Ruptured congenital aneurysm.

Part II: is for other conditions, not related to those listed in Part I, that have also contributed to death.

- Don’t record the mode of death (e.g. coma, heart failure) in isolation, it should be qualified by indicating the underlying pathological abnormality.
- In the UK ‘Ia: Old age’, sudden infant death syndrome (SIDS) is acceptable as causes of death.
- International classifications of disease are now well established as: International Statistical Classification of Diseases and Related Health Problems (ICD), which can be used for both clinical diagnoses and death certificates. In this classification, each condition is given a four-digit ICD code.

Medico-legal investigation of death:

- If a death is natural and a doctor can sign a death certificate, this allows the relatives to continue with the process of disposal of the body. If the death is not natural or if no doctor can complete a death certificate, some other method of investigating and certifying the death must be in place.
- The systems are arranged to identify and investigate deaths that are, or might be, **unnatural, overtly criminal, suspicious, traumatic or caused by poisoning**, or that might simply be deaths that are **unexpected or unexplained**.
- The types of deaths that cannot be certified by a doctor are examined by: **Coroners, procurators fiscal, medical examiners, magistrates, judges and even police officers**.
- Registrars of Deaths have a duty to inform the Coroner about any death that appears to be unnatural or where the rules about completion of the death certificate have not been complied with.
- The Coroner will attempt to find a family practitioner, if found, may be able to complete the death certificate if he is aware of natural disease and if the scene and circumstances of the death are not suspicious.
- If no family practitioner can be found, or if the practitioner is unwilling to issue a death certificate, the Coroner will require an autopsy.
- Autopsy examinations are not the final answer to every death, but without an internal examination it can be impossible to be certain about the cause and the mechanism of death. Deaths are usually referred to the Coroner by doctors, police and members of the public.

Autopsies can be performed for two reasons:

- 1- **Clinical interest:** after consent for the examination has been granted by, the relatives eg: for teaching medical students and research (in the past)
 - 2- **Medico-legal purposes:** Autopsies can, in theory, be performed by any doctor, but ideally they should be performed by a properly trained pathologist.
- The first crucial part of any autopsy is **observation and documentation**.
 - Many autopsies will require ancillary investigations, such as radiological, toxicological, biochemical and microscopic analyses.

Exhumation: A body which is removed from its grave for further examination.

CHAPTER (4): IDENTIFICATION OF THE LIVING AND DEAD

- Loss of identity, either **deliberate** (e.g. because someone does not wish their identity to be known, or wishes to conceal the identity of another) or **unintentional** (e.g. in mass disasters, etc).
- Proper identification of a body is one of **the key questions** to be answered when a body is found and in the investigation of any death and forms the first part of a **Coroner's inquest** (Chapter 3).
- Start with the **visual identification**.

Identification criteria:

- **Primary identification criteria are** fingerprints, DNA, dental and unique medical characteristics.
- **Secondary criteria include** deformity, marks and scars, X-rays, personal effects and distinctive clothing.

- The detailed assessment of the dead for evidence of identity is a specialized task for a multi-professional team that includes **the forensic pathologist, forensic odontologist, anthropologist, radiologist, and other experts**.

DNA profiling:

The chances of two unrelated individuals sharing the same sequence is one in a billion, or higher. Only uni-ovular twins have the same sequences.

Examination of dental structures:

- The **forensic odontologist** is of prime importance in mass disasters where trauma is likely to make visual identification impossible. (Figure 4.1 Dental chart page 36)
- The great advantage of dental identification is that the teeth are the hardest and **most resistant tissues** in the body and can survive total decomposition and even severe fire, short of actual cremation. Pre-existing dental records and charts and radiographic images can be **compared** with examination of teeth of the deceased. Where no previous records are available, examination of the mouth and the teeth can still give some general information on **age, sex, diet and ethnic origin**.

Fingerprint:

Prints may often be obtained from desquamated skin or from the underlying epidermis after shedding of the stratum corneum following prolonged submersion.

Morphological characteristics:

Established by matching the parameters that can be measured or seen on an individual with the **same parameters** that were known to apply to, or to be present on, a named individual. In both the living and dead, the height, weight and general physique need to be recorded and **compared**. Hair colour and length, including bleaching or dyeing, etc.

Tattoos and body piercings:

The main use of tattoos and piercings in forensic medicine is in the identification of the bodies of **unknown persons**. Decomposing bodies should be examined carefully for tattoos, which may be rendered more visible when the superficial desquamated stratum corneum is removed. Also note the site and type of **body piercing**.

Identity of decomposed or skeletalized remains:

Phalanges, carpal and tarsal bones can be **extremely difficult** to positively identify as human because some animals, such as the bear, have paw bones almost identical to the human hand.

- **The skull and the pelvis** offer the best information on **sexing** and the examination by an anthropologist or anatomist is vital.
- **Age:** will require a multi-professional approach.
- **Race:** is very much the field of trained anthropologists.

Body implants:

May either relate to the cause of death or may simply be an incidental finding. Most body implants (e.g. pacemakers, joint replacement) bear a unique reference number which identify the maker. These and other unique medical data are often useful in establishing identity.

Where pre-mortem clinical radiographs are available, **the comparison** of these with the post-mortem films may give a definite identity. If a skull X-ray is available, comparison of **the frontal sinus patterns** is incontrovertible as **no two people have the same frontal sinus outline**.

Mass disasters:

A mass disaster requires appropriate collection of forensic samples. Fingerprints and DNA samples can be obtained from personal items. **Body recovery teams** will identify where the deceased are and then once identification evidence has been collected this will be presented to the **Identification Commission** who will decide if it meets the standards required to confirm identity. **Multiple deaths** are caused by some form of disaster the process of Disaster Victim Identification (**DVI**) should be established.

Age estimation in the living:

- Only few doctors have the knowledge or skills of assessing age or be aware of the limitations. The **essential element** of any age estimation procedure is to ensure that it complies with, and fulfils, all local and/or national legal and ethical requirements.
- **Underestimation** of age is unlikely to raise any issue in relation to an infringement of human rights (as younger persons tend to be treated better in law) but an **over-estimation** of age can have adverse effects.
- The **4 means of assessment** that should be used now to estimate age in the living are:
 - 1- **Social and psychological evaluation.**
 - 2- **External estimation of age.**
 - 3- **Skeletal estimation of age** (not visually but relies on technology to assist with informed consent).
 - 4- **Dental estimation of age.** **Evaluation must be undertaken by a qualified clinician.** External estimation of age should use **Tanner staging Figure 4.3 page 40** to assess child maturity however, Pubertal and post-pubertal individuals require a radiographic investigation.

CHAPTER (5): THE APPEARANCE OF THE BODY AFTER DEATH

- **Rapid changes after death:** fall in blood pressure, all nervous activity ceases, the reflexes are lost and breathing stops, corneal reflex ceases and the pupils stop reacting to light, retinal vessels show the break-up or fragmentation of the columns of blood, which is called 'trucking' or 'shunting'. The muscles rapidly become flaccid (primary flaccidity), with complete loss of tone, but they may retain their reactivity and may respond to touch or taps and other forms of stimulation for some hours after cardiac arrest. Skin, conjunctivae and mucous membranes are pale, face and the lips may remain red or blue in colour in hypoxic/congestive deaths. Loss of muscle tone may result in voiding of urine, Emission of semen is also found but cannot be used as an indicator of sexual activity shortly before death. Regurgitation of gastric contents is a very common feature cannot be used to indicate that gastric content aspiration was the cause of death unless associated with inflammatory response.
- **Rigor mortis:** develops uniformly throughout the body but it is generally first detectable in the smaller muscle groups such as those around the eyes and mouth, the jaw and the fingers. It has very little utility as a marker of the PMI because of the large number of factors that influence it (eg. in a cold body, the onset of rigor will be delayed). It is best to test for rigor across a joint using very gentle pressure from one or two fingers.
- **Cadaveric rigidity:** is said to be the stiffness of muscles that has its onset immediately at death.
- **Post-mortem hypostasis:** pink or bluish color to the lowest areas of the body and it is this colour change that is called post-mortem hypostasis or lividity.

- **Cooling of the body after death:** **Newton's Law of Cooling states** that heat will pass from the warmer body to the cooler environment and the temperature of the body will fall.

- **Decomposition/putrefaction:** the warmer the temperature, the earlier the process starts and the faster it progresses. In temperate climates, the process is usually first visible to the naked eye at about 3-4 days as an area of green discoloration of the right iliac fossa of the anterior abdominal wall. This '**greening**' is the result of the extension of the commensal gut bacteria through the bowel wall and into the skin, where they decompose haemoglobin, resulting in the green colour. When present in the superficial vessels, results in linear branching patterns of variable discoloration of the skin that is called '**marbling**', the **prostate** and the **uterus** are relatively resistant to putrefaction and they may survive for months, as may the **tendons and ligaments**, bones may remain for years.

- **Immersion and burial:** Immersion in water or burial will slow the process of decomposition. **Casper's Law (or Ratio) states** that: if all other factors are equal, then, when there is free access of air, a body decomposes twice as fast than if immersed in water and eight times faster than if buried in earth. The level of moisture in the surrounding soil and acidity of the soil will both significantly alter the speed of decomposition.

- **Adipocere:** most commonly seen in bodies found in wet conditions. In the early stages of formation, adipocere is a pale, rancid, greasy semi-fluid material with a most unpleasant smell. When fully formed, adipocere is a grey, firm, waxy.

- **Skeletalization:** in a formally buried body, the soft tissues will be absent by 2 years. Examination of the bone marrow space may reveal residual organic material that can sometimes be suitable for specialist DNA analysis.

- **Post-mortem injuries:** It is not true to say that post-mortem injuries do not bleed because many do leak blood. In general, post-mortem injuries do not have a rim of an early inflammatory response in the wound edges.

Box 5.1 Examples of factors affecting the rate of cooling of a body

- Mass of the body
- Mass/surface area
- Body temperature at the time of death
- Site of reading of body temperature(s)
- Posture of the body – extended or curled into a fetal position
- Clothing – type of material, position on the body – or lack of it
- Obesity – fat is a good insulator
- Emaciation – lack of muscle bulk allows a body to cool faster
- Environmental temperature
- Winds, draughts, rain, humidity

- **Estimation of the post-mortem interval:** the most reliable would appear to be related to the cooling of the body after death. Currently, the most useful method of estimating the time of death is **Henssge's Nomogram** which relies on three measurements - body temperature, ambient temperature and body weight.

Forensic entomologist, who can determine a probable time of death - in the region of days to months - from examination of the populations and stages of development of the various insects that invade a body.

Notes from the doctor:

- **Decomposition:**

- 1- Autolysis (due to body enzymes).
- 2- Putrefaction (due to bacterial normal flora). First part of the body that will undergo putrefaction is **Cecum**.

- **Skeletalization:** due to

- 1- Autolysis and putrefaction.
- 2- Eaten by animal (if you notice that the deceased has lost his **lips** and **nose** > think about a **cat** in house).

- **Mummification** is natural in Dry Climate.

CHAPTER (6): UNEXPECTED AND SUDDEN DEATH FROM NATURAL CAUSES

Body must be examined after death unless it had been examined by the doctor in the previous 14 days. Definition of sudden death is one that occurs **-24 hrs** of onset of symptoms. In Forensic medicine it may occur even mins/secs prior to death. Sudden and unexpected death are not synonymous but they're often combined.

Cardiovascular system:

Disease of the heart: When natural death is very rapid the most common cause of irreversible cardiac arrest is a *cardiovascular abnormality*.

A. Coronary artery disease: Narrowing of the lumen by atheroma leading to chronic ischemia.

- Bleeding into a plaque > seen as **sub-intimal hemorrhage** at autopsy.
- Area of infarct is weak after **3 days - 1 week** of clinical onset of infarct. Its rupture leads to sudden death from a haemopericardium and cardiac tamponade.

B. Hypertensive heart disease:

- Normal heart weight 400 g for the average man.
- Enlarged heart > chronic myocardial hypoxia and electrical instability + 'trigger' a fatal arrhythmia.

C. Primary myocardial disease: The cardiomyopathies comprise a group of disorders including:

- Hypertrophic cardiomyopathy (HCM): symmetrical/asymmetrical hypertrophy, a sub-aortic mitral 'impact lesion' and myocyte disarray.
- Dilated cardiomyopathy (DCM): may be a 1ry or 2ry (to chronic alcohol misuse).
- Arrhythmogenic right ventricular cardiomyopathy (ARVC): rightventricular thinning with fibro-fatty myocyte replacement.

- Channelopathies: Small proportion of cardiac sudden deaths with normal investigations (**with a structurally normal heart**). Often ‘triggered’ by a stimulus (**exercise**, sudden loud noise). Such deaths fall under sudden adult death syndrome (SADS).

Disease of the arteries:

- The most common lesion of (extracardiac) arteries associated with sudden death is the **aneurysm**.

A. Atheromatous aneurysm of the aorta:

- Most commonly found in **elderly** in the **abdominal aorta**.
- Saccular (expanding to one side) or fusiform (cylindrical).
- Bleeding into retroperitoneal space.

B. Dissecting aneurysm of the aorta:

- The commonest site is in the **thoracic aorta** with dissection tracking distally.
- Found in individuals with hypertension. May also be seen in younger individuals with **connective tissue defects**, such as Marfan syndrome.

C. **Syphilitic aneurysms**: Rare. Seen in autopsies of elderly. Found in arch of thoracic aorta. Rupture causes torrential hemorrhage.

Intracranial vascular lesions:

A. Ruptured berry aneurysm:

Common cause of sudden collapse/rapid death of young - middle aged men/women is **subarachnoid haemorrhage** from ruptured berry aneurysm of the basal cerebral arteries. Clinically silent or causing severe headache, neck stiffness, unconsciousness/other neurological symptoms. Classic scenario: intoxicated individual receives blow to head. Collapses and suffers cardiac arrest.

B. Cerebral hemorrhage, thrombosis and infarction:

- Bleeding common in **old age** and with **HTN**.
- Sudden expansion of hematoma compresses internal capsule > hemiplegia.

Respiratory system:

Major cause of sudden death is **vascular**. Most commonly - and often underdiagnosed - is **pulmonary embolism**. Associated with immobility. Interfere with pulmonary function and lead to myocardial ischemia/ cardiac arrest.

GI system:

Major cause of sudden death is **vascular**.

- Severe bleeding from ulcer.
- Mesenteric thrombosis/embolism related to atherosclerosis.
- Strangulated hernia > intestinal infarction.
- Torsion of bowel / adhesions > obstruction.
- Peritonitis.

Gynecological conditions: **Illegal abortions.**

Epilepsy and asthma:

- Asthma: hyper-inflated lungs and mucus plugging on autopsy.
- Epilepsy: May be specific (e.g., drowning from seizure while swimming) or unspecific (sudden unexpected death in epilepsy).

CHAPTER (8): INJURY ASSESSMENT, CLASSIFICATION AND DOCUMENTATION

Introduction: 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.

Most harm or injury can be embraced by one of the following broad groups:

1- Those with a fatal outcome:

- Murder
- Manslaughter

2- Those without a fatal outcome:

- Assault, assault occasioning actual bodily harm
- Common assault
- Battery, or common battery
- Wounding or wounding with intent
- Poisoning
- Inflicting grievous bodily harm or causing grievous bodily harm with intent.

3- Sexual offences:

- Penetrative
- Non-penetrative (both with or without extra - genital injury).

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: (depending on the cause)

- 1- By physical force can be 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: it is 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. Blunt-force trauma may have a number of outcomes:

- No injury.
- Tenderness.
- Pain.
- Reddening (erythema)
- Swelling (oedema)
- **Bruising (contusion)**
- **Abrasions (grazes)**
- **Lacerations**
- Fractures.

- Blunt injuries described (in terms of force applied) as being weak (for example a 'gentle' slap on the face), weak/moderate, moderate, moderate/severe or severe (for example a full punch as hard as possible).
- The more forceful the impact the more likely that visible marks.

- Reddening describes increased blood supply.
- Red bruises have the ability to blanch from finger pressure.
- Haematoma refers to a palpable collection of blood under the skin.
- Petechiae are small bruises, often described as "pin-point hemorrhages", < 2 mm

Bruises (ecchymosis): It is Leakage of blood into underlying tissues from damaged blood vessels. Two events must occur before a bruise can form: **damage to the small blood vessel**, and the leakage of the blood into surrounding tissues (skin or deep tissue). 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: Is 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).



Lacerations: appear as ‘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, the same blunt force causing such a laceration may also cause irregular splits, bruising and abrasion at the margins of the wound.



- 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).

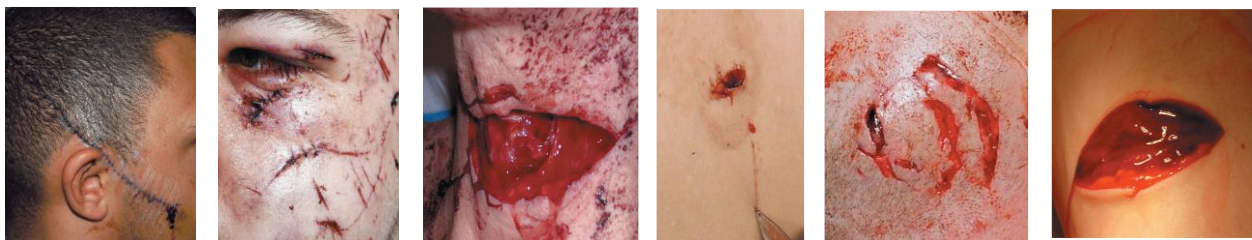
Sharp-force injury:

- 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.
- A surgical operation wound is an example of an incised wound.
- 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. Stab-like wounds may also be caused by (relatively) blunt objects such as screwdrivers or car keys. 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. 2- The sharpness of the ‘cutting edge’ of the implement. 3- The nature of the force applied. 4- Whether clothing has been penetrated (thick leather jackets may offer significant resistance to penetration). 5- Whether bone has been injured (bone tends to suggest that a greater force has been used to inflict the wound).



Chop injuries: caused by a variety of implements that are generally heavy, and relatively blunt, bladed instruments. These include some machetes, Samurai swords and axes. Fractures and amputations may also result from the use of such implements and substantial scarring may ensue.



Other types of injury pattern:

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.

Kicking and stamping: Blows from the foot are commonly directed towards the head and face, the chest and the abdomen. Stamping injuries to the front of the abdomen may result in rupture of any of the internal organs.

Bite injuries: Bite marks can be seen in sexual assaults, child abuse and occasionally on the sports field. A forensic odontologist should review any possible bite marks when confirmation of identity of the biter is required. The neck, breasts and shoulders are often bitten in a sexually motivated attack, while in child abuse bites to the arms and the buttocks are common. If a suspected bite is found at examination, a swab of the area should be taken for DNA and the bite should be photographed with a scale.

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 (The arms and hands sustain injuries but the head is protected).

Defence-type injury after blunt weapon assault will be seen in the same regions, namely the extensor surfaces of arm and upper arm.



Survival after injury:

The length of survival following infliction of an injury is difficult to determine: every human being is different. Many examples exist of individuals with apparently potentially immediately fatal wounds who have performed purposeful movements/actions for some time after the 'fatal' injury.

Self-inflicted injury:

Fatal self-inflicted blunt-force injuries may be inflicted following jumping from a height or under a train. Self-inflicted bite marks may occasionally be seen on the arms of an individual who claims to have been assaulted or blunt force injuries to the head or other parts of the body.

Self-inflicted incised or stabbing injuries, show specific patterns that vary depending on the aim of the individual. In suicidal individuals, self-inflicted sharp-force injuries are most commonly found at specific sites on the body called '**elective sites**'; for incised wounds these are most commonly on the front of the wrists and neck, whereas stabbing injuries are most commonly found over the precordium and the abdomen.

The other features of self-inflicted injuries lie in the multiple, predominantly parallel, nature of the wounds and, in suicidal acts, the more superficial injuries are referred to as '**hesitation**' or '**tentative**' injuries (Figure 8.32).

Torture:

The physical examination must involve systematic examination of the skin, face, chest and abdomen, musculoskeletal system, genitourinary system and the central and peripheral nervous systems. Specific examination is required. Specialized diagnostic tests may be required to assess damage (e.g. nerve conduction studies).



The history taking should include direct quotes from the victim, establishment of a chronology backing it up with old medical records and photos. A summary of detention settings, and abuses, must be obtained with details. Attention must also be paid to psychological status of the victim. Specific torture techniques that may be described include:

- Beating of the soles of the feet.
- Amputation.
- Positional torture
- Suspension
- Electrical burns.



Documentation of injury or marks of injury:

Forensic physicians dealing with the injured living person may be able to get a history directly from that person. If it is possible to take a history, then the relevance of factors such as those listed below should be considered:

- Time of injury or injuries.
- Has injury been treated (e.g. at hospital or at home).
- Pre-existing illnesses (e.g. skin disease).
- Regular physical activity (e.g. contact sports).
- Regular medication (e.g. anticoagulants, steroids).
- Handedness of victim and suspect.
- Use of drugs and alcohol.
- Clothing worn.

- **The following characteristics should be recorded wherever possible for each injury:** Location (anatomical - measure distance from landmarks) - Pain - Tenderness - Reduced mobility - Type (e.g. bruise, laceration, abrasion) - Size - Shape - Color - Orientation - Age - Causation - Handedness - Time - Transientness.

- **The recording of such information in the clinical setting should ideally be in three forms:** written form, hand-drawn body diagram and digital image form.

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

- Any trauma to the head or face that has the potential for damaging the brain can have devastating consequences. Normally the brain is protected within the bony skull, but it is not well restrained within this compartment and injuries to the brain result from differences between the motion of the solid skull and the relatively 'fluid' brain. There are three main components of the head: the scalp, the skull and the brain.
- The clinical significance of any space-occupying lesion (e.g. intracranial haemorrhage) within the cranial cavity is the effect that the raised intracranial pressure caused has on brain structure and function.

Scalp:

- Bruises of the scalp are associated with prominent edema.
- 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.
- 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.



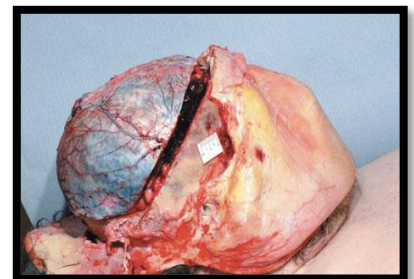
Skull fractures:

- The complexity of the skull structure means that mechanisms of skull fracture can be extremely complex as a result of both direct force (e.g. direct impact to the parietal bone causing a linear fracture) and indirect force (e.g. an orbital blowout fracture caused by impact to the eyeball).
- The site of fracture therefore represents that point at which the delivered energy has exceeded the capability of the skull to distort, which is not necessarily at the site of impact, 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, scalp injury overlying skull fracture may be associated with minimal (or no recognizable) brain injury or neurological deficit.
- A direct blow to the nose can cause blunt force injuries to the nose itself, but may also cause bilateral periorbital bruising.
- Blows to the top of the head commonly result in long, linear fractures that pass down the parietal bones.
- 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.

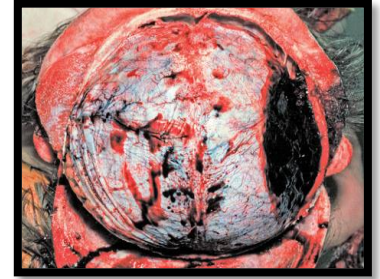


Intracranial haemorrhage:

- The anatomy of the blood vessels within the skull has a major influence on the type of bleeding.
- 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.
- Extradural haemorrhage is associated with damage to the meningeal artery, particularly the middle meningeal artery.

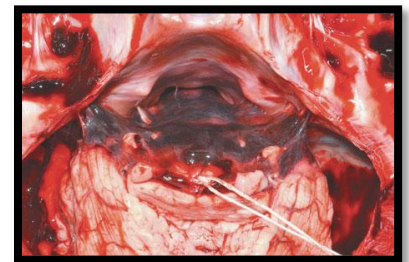
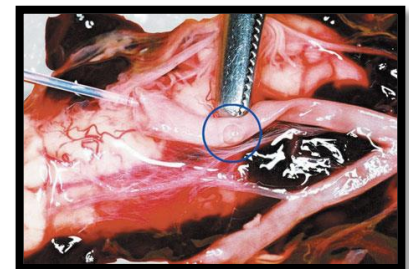


- Extradural hemorrhages are ones that in the clinical setting may present with head trauma and then a ‘lucid period’ of half an hour or more, before rapid deterioration. Rarely, extradural haemorrhage can develop as a result of venous bleeding.
- Subdural haemorrhage is associated with damage to the communicating veins. This venous damage is not necessarily associated with fractures of the skull.
- Recent subdural haemorrhages are dark red in color and shiny, Microscopically, hemosiderin can be identified with Perl’s stain
- Chronic subdural haematomas are seen in those prone to frequent falls, and elderly, whose cerebral atrophy allows space for the formation of the haematoma without apparent significant clinical effect.



Traumatic subarachnoid haemorrhage:

- Small areas of subarachnoid haemorrhage are common where there has been direct trauma to the brain, either from an intrusive injury, or from movement of the brain against the inner surface of the skull.
- Large basal subarachnoid haemorrhages can be of traumatic origin and follow blows or kicks to the neck.
- The vertebral arteries are confined within foraminae 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 of one of the arteries in the circle of Willis.



Brain injury:

- Injuries that have resulted in skull fractures or intracranial haemorrhage are clear macroscopic markers of significant force having been applied to the head and therefore to the brain.
- 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).

- Direct injuries to the brain from depressed or comminuted skull fractures result in areas of bruising and laceration of the cortex,
- 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.

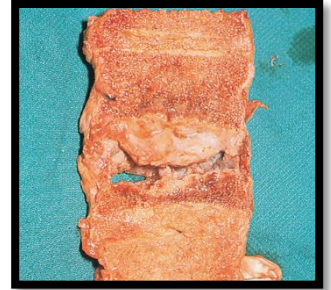
2- Neck injuries

- 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 structures.
- In a 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- Arterial injury: suspicious death
 - 2- venous injury: possibility 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.
- Spinal damage will depend upon:
 - 1- anatomical site
 - 2- Mechanism of injury.
 - 3- The type of injury: depends upon degree of force and the angle at which the spine is struck.
- Structures in the spinal cord that can be affected: the discs, the vertebral bodies, the neural, arches and the transverse processes.
- Whiplash injuries in road traffic fatalities are associated with: Hyperextension of the neck.
- Hyperflexion injuries can be caused if heavy weights are dropped onto the back of a crouching individual.

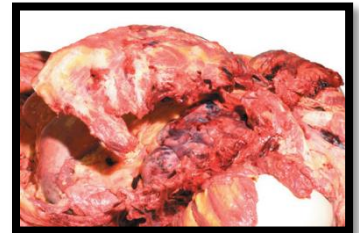
- Forceful extension of the spine: are rare, causes cervical injuries and associated with judicial hanging. In this kind of injuries there is:
 - 1- Long drop before the sudden arrest
 - 2- Forceful extension of the neck.
- Forceful flexion of the spine: Will commonly lead to the ‘wedge’ fracture or compression of the anterior aspect of a vertebral body.



4- Chest injuries:

Blunt injuries:

- Results 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.
 - 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, haemopneumothorax
 - 2- Outward: Pneumothoraces.
- Rib fractures in children 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 (CPR).
- Note: when a microscopic examination of rib fractures identified at post-mortem examination is required ?? If there is evidence of ‘healing changes’.



Penetrating injuries

- The effect of the penetration will depend mainly upon which organ(s) or vessel(s) are injured.
- It can lead to the development of pneumothorax, haemothorax or a combination (haemo-pneumothorax).
- At post-mortem examination: it is not unusual to find several liters of blood within the chest cavity, because hemorrhage from penetrating injuries to the chest may remain concealed with little external evidence of bleeding.

5- Abdomen

Blunt force injuries:

- Blunt force injuries especially in the anterior/posterior direction can cause compression of the organs lying in the midline against the vertebral column, which in order causes injury to intra-abdominal organs, including:
 - 1- Bruising (or transection) of the duodenum or jejunum.
 - 2- Rupture of the pancreas
 - 3- Rupture of the liver
 - 4- Disruption of omentum and mesentery
- The forces required to cause these injuries is severe and they are commonly encountered in road traffic collisions.
- Kicks and stamps are commonly the cause of major trauma.
- The kidneys and the spleen are susceptible to direct trauma + to rotational forces causes avulsion from their vascular pedicles.
- Spleen is sometimes associated with delayed rupture leading to haemorrhage and possibly death some hours or even days after the injury.
- Pancreatic trauma may lead to the development of a pseudocyst, with little or no short-term or long-term sequelae.
- In children: Abdominal injuries may have the same causes, but the force required to cause injury is reduced. Also a slower compressive forces associated with squeezing of the abdomen during abuse may also result in those kind injuries.
- Intraabdominal injuries could be caused by CPR but rarely.



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.
- Post-mortem: peritonitis and blood clots are both factors which may give indications of how long before death intra-abdominal trauma had occurred.

CHAPTER (15): ASPHYXIA

Types of Asphyxia:

- Mechanical:
 - Strangulation.
 - Hanging (معلق من مكان يعني الوزن له دور)
 - Choking (physical obstruction within the airways)
 - Compression asphyxia (شي ضاغط على البطن او الصدر)
 - Smothering (شي يغطي الأنف والفم)
- Non-mechanical:
 - Carbon monoxide poisoning.
 - Cyanide poisoning.
- Drowning.

Asphyxia episodes:

The general sequence of events currently described in most 'Asphyxial episodes' is: the **dyspnoea phase, convulsive phase, pre-terminal respiratory phase, then gasping for breath followed by the terminal phase.**

Box 15.1 Sequence of events that may be seen in asphyxial episodes

- **Dyspnoea phase** – expiratory dyspnoea with raised respiratory rate, cyanosis and tachycardia (may last for a minute or more)
- **Convulsive phase** – loss of consciousness, reduced respiratory movements, facial congestion, bradycardia, hypertension, fits (may last for a couple of minutes)
- **Pre-terminal respiratory phase** – no respiratory action, failure of respiratory and circulatory centres, tachycardia, hypertension (may last a couple of minutes)
- **Gasping for breath** – respiratory reflexes
- **Terminal** – loss of movement, areflexial, pupillary dilatation

Traditionally, the 'classic signs of asphyxia' were described as:

- petechial haemorrhages in the skin of the face and in the lining of the eyelids
- congestion and oedema of the face
- cyanosis (blue discoloration) of the skin of the face
- right heart congestion and abnormal fluidity of the blood

However these are not specific to asphyxia but the finding of petechiae in the face/neck is of most importance to the forensic pathologist.

In survivors of an 'asphyxial episode', careful clinical examination may show:

- Pain and tenderness around the neck and structures within the neck.
- Damage to the larynx and associated cartilages.
- Damage to the hyoid bone.
- Dried saliva around the mouth.
- Cyanosis (particularly if the survivor is found immediately after the attack).
- Congestion and oedema of the structures above any level of compression.
- Petechiae above the level of the compressive force that has caused the asphyxia.
- Haemorrhage from the mouth, nose and ears, presumably as a consequence of raised intravascular pressure; incontinence of faeces and urine.

Types of mechanical asphyxial mechanisms:

- Pressure to the neck:

Three forms of the application of direct pressure to the neck are of importance in forensic medicine, namely manual strangulation, ligature strangulation and hanging.

The application of pressure to the neck may lead to any of the following, the precise nature of which is dependent upon the type, site and extent of the pressure applied:

- Obstruction of the jugular veins, causing impaired venous return of blood from the head to the heart (leading to cyanosis, congestion, petechiae)
- Obstruction of the carotid arteries which, if severe, causes cerebral hypoxia
- Stimulation of carotid sinus baroreceptors at the bifurcation of the common carotid arteries resulting in a neurologically mediated cardiac arrest
- Elevation of the larynx and tongue, closing the airway at the level of the pharynx (unless extreme pressure is applied to the neck, the cartilaginous trachea is more resistant to compression).

Following mechanical pressure to the neck, loss of consciousness can occur rapidly; traditionally, loss of consciousness following hanging was thought to occur within 10 seconds, filmed hanging analysis suggests a lack of recognizable respiratory movements after 2 minutes and a lack of muscle movements after 7.5 minutes.

- 'Vagal inhibition' or reflex cardiac arrest:

It has been recognized for some time that the mechanical stimulation of the carotid sinus baroreceptors in the neck can result in an unpredictable, and sometimes fatal, outcome.

- **Strangulation:**

Manual strangulation is used to describe the application of pressure to the neck using the hands, and is a relatively common mode of homicide, particularly where there is disparity between the sizes of the assailant and victim. **The external signs of manual strangulation can include bruises and abrasions on the front and sides of the neck, and the lower jaw; Bruises caused by fingertip pressure and fingernail scratches may be seen**, the latter being made either by the assailant or the victim.

When pressure to the neck is sustained, additional features of manual strangulation can include **the ‘classic asphyxial signs’**, including **facial petechiae**. In the **living victim**, clinical evaluation may reveal **pain on swallowing, hoarseness, stridor, neck, head or back pain**.

Ligature strangulation may be **homicidal, suicidal or accidental** and involves the application of pressure to the neck by an item capable of constricting the neck, **(like holding a belt around someone’s neck until he dies)**.

There is frequently a clear demarcation of congestion, cyanosis and petechiae above the level of the constricting ligature, and there is usually a **‘ligature mark’** on the neck at the site of constriction (so the belt will leave a mark on the neck).

Soft and broad-surface ligatures, however, may leave very little evidence of compression on the skin of the neck, or even injury to underlying structures.

Distinguishing ligature strangulation from hanging, in which the individual’s body weight against a ligature leads to pressure being exerted on the neck (Strangulation vs hanging).

The **‘strap muscles’** in the neck and injury to the superior horns of the **thyroid cartilage**, are particularly **vulnerable to compressive injury**. Calcification and ossification of the hyoid bone and thyroid cartilage occurs with increasing age, and such change is **associated with less flexible structures that are more prone to injury following neck compression**.

- **Hanging:**

Hanging describes suspension of the body by the neck (الجسم يكون معلق). Any material capable of forming a ligature can be used for hanging. **The pressure of the ligature on the neck is produced by the weight of the body**. As with ligature strangulation, a **ligature mark is commonly present**.

Hanging by judicial execution involves a 'drop', for example through a trapdoor, calculated to **result in cervical spinal cord injury and fracture-dislocation of the cervical spine**, but without decapitation.

- **Choking:**

Accidental ingestion of objects or food can cause choking, the internal obstruction of the upper air passages by an object or substance impacted in the pharynx or larynx. Choking is, most commonly, **accidental** and common causes include **misplaced dentures** (fake teeth) in adults and **inhaled objects** such as small toys, balls, etc., in children. **In medical practice there are risks associated with individuals who are sedated or anaesthetized. Obstruction commonly leads to respiratory distress with congestion and cyanosis of the head and face.**

Café coronary: One of the commonest causes of choking is the entry of food into the air passages. If food enters **the larynx** during swallowing, it usually causes **gross choking symptoms of coughing, distress and cyanosis**, which can be fatal unless the obstruction is cleared by coughing or some rapid treatment is offered.

However, if the piece of food is large enough to occlude the larynx completely, **it will prevent not only breathing but also speech and coughing**. The individual may die silently and quickly, the cause of death remaining hidden until the autopsy.

- **Compressional and positional asphyxia:**

Pressure on the trunk (chest and/or abdomen) can result in an inability to breathe effectively and result in death (**unable to expand their chests to breath**).

Occasionally, individuals are crushed by the weight of many other people fleeing danger, such as during a fire in a sports stadium (like in hajj) or they may, for example, attempt to squeeze through small gaps in railings, or small open windows, and become wedged preventing expansion of the chest (يعني يدخلون أماكن ضيقة ماتكفيهم).

- **Suffocation and smothering:**

Suffocation is a term usually used to describe a **fatal reduction of the concentration of oxygen in the respired atmosphere**, and often incorporates 'smothering'. A reduction in atmospheric oxygen can occur, for example, in a decompressed aircraft cabin, or in a grain silo. **Mechanical obstruction of the upper airways can lead to suffocation, as is seen when plastic bags are accidentally, homicidally, or suicidally placed over the head** (يعني الأكسجين المحيط بالشخص يقل بدرجة شديدة زي اللي ينامون في بيت شعر مسكرين النوافذ ومولعين المشب).

Similarly, smothering - **the physical occlusion of the nose and mouth** - may leave no 'asphyxial signs' in survivors or the deceased. If the individuals are unable to struggle, owing to extremes of age or intoxication, for example, they may have no evidence of injury, including around the mouth or nose

- **Autoerotic asphyxia:**

Autoerotic asphyxia is the term used to describe those **fatalities occurring during some form of solitary sexual activity**.

The recurrent feature tends to be the use of a device, appliance or restraint that causes neck compression, leading to cerebral hypoxia, with the aim of heightening the sexual response.

The presence of the following features should be considered when 'diagnosing' autoerotic asphyxiation: evidence of solo sexual activity; private or secure location; evidence of previous similar activity in the past; no apparent suicidal intent. The presence of injuries suggestive of assault must be looked for carefully, and the possibility of third-party involvement must always be considered in such cases.

- **Example of Asphyxial Conditions:**

Underlying cause of death	Name
Lack of oxygen in the inspired air	Suffocation
Blockage of the external orifices	Suffocation/smothering
Blockage of the internal airways by obstruction	Gagging/choking
Blockage of the internal airways by external pressure	Strangulation/hanging
Restriction of chest movement	Traumatic asphyxia
Failure of oxygen transportation	(For example carbon monoxide poisoning)
Failure of oxygen utilization	(For example cyanide poisoning)

MCQs:

20. The width of ligature mark on skin may not correspond with ligature when the ligature used is a
- (a) Rope
 - (b) Woven belt
 - (c) Nylon or silk fabric
 - (d) Electric wire
44. Death in judicial hanging is due to
- (a) Shock
 - (b) Fracture-dislocation of upper cervical
 - (c) Rapid asphyxia
 - (d) Inhibition of the heart
107. Choking
- (a) It is a form of asphyxia caused by mechanical occlusion within air passages by a solid object
 - (b) A twig of madar 20 cm long
 - (c) It is practised in India by dais
 - (d) Occurs due to closure of external respiratory orifices
113. "Cafe coronary" is
- (a) A type of death due to choking
 - (b) Sudden death due to coronary thrombosis
 - (c) Death due to alcoholic cardiomyopathy
 - (d) Food poisoning
114. The cause of death in cafe coronary is
- (a) Asphyxia
 - (b) Coronary thrombosis
 - (c) Sudden heart attack
 - (d) Laryngeal spasm

Answers:

20- C

44- B

107- A

113- A

114- A

CHAPTER (16): IMMERSION AND DROWNING

Drowning: is a mixture of both mechanical presence of water within the respiratory system (causing a mechanical asphyxia) and fluid and electrolyte changes which vary according to the medium (sea water versus fresh water).

- SEA water: is hypertonic results in fluid shifts into alveoli
- FRESH water: is hypotonic and It causes alveolar collapse/atelectasis.
- **Dry drowning** if there is no autopsy signs of aspiration of water like because of trauma.
- **Aspiration water** leads to *hypoxaemia* causing myocardial depression, reflex pulmonary vasoconstriction and altered pulmonary capillary permeability, contributing to pulmonary oedema.

Examples of reasons for death in a body recovered from water:

- Died of **natural causes before** entering the water (eg. a myocardial infarction).
- Died of **natural causes while** in the water, having entered the water either voluntarily or accidentally (e.g. micturating into a canal and losing balance).
- Died from exposure and **hypothermia** in the water.
- Died of **injuries before** entering the water.
- Died of **injuries after** entering the water.
- Died from **submersion**, but not drowning
- Died from true drowning as a result of **aspiration** of water.

Evidence of immersion:

- **Wrinkled** hand and feet skin (washerwoman's fingers).
- Then, wrinkled skin begins to **separate**.
- **Bloating** of the body due to gas formation in soft tissues (Gaseous decomposition and bloating often causes the body to 'float to the surface' leading to its discovery).



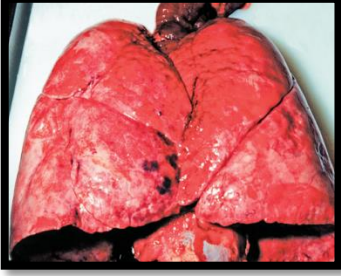



Pathological diagnosis of drowning: Pulmonary surfactant insufficiency, pulmonary oedema, alveolitis, hypoxaemia and metabolic acidosis.

Other investigations in bodies recovered from water:

- Post-mortem **blood chloride** and specific gravity analyses (to differentiate fresh and sea water drowning).

- **Diatoms** which are microscopic organisms present in water (has been taken to imply that an individual found in the water).

Findings that may be associated with drowning:

		
<p>Peeling of the epidermis from the foot (degloving) following a few weeks of immersion.</p>	<p>'Washer woman's hands'. Waterlogged skin after 1 week of immersion in a cold climate.</p>	<p>Emphysema aquosum following drowning. The lungs are hyperinflated, crossing the midline and obscuring the pericardial sac. There are subpleural haemorrhages in the right lung middle lobe (Paultauf's spots).</p>
		
<p>Frothy fluid exuding from the mouth following drowning</p>	<p>Post-mortem injuries caused by marine creature predation.</p>	<p>Such injuries are likely to have been caused by contact against the river bed.</p>

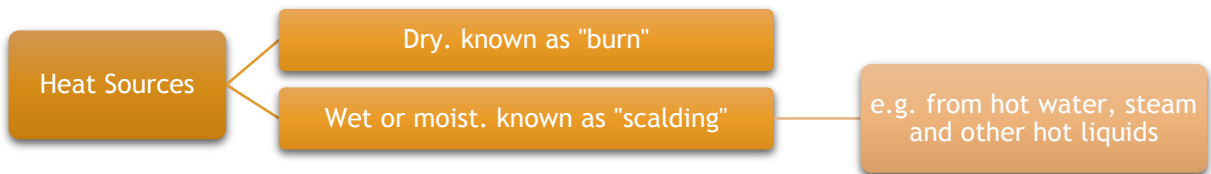
Important notes:

- Estimating the post-mortem interval from signs of immersion, and decomposition, in a body recovered from water is completely unreliable.
- Co-stimulation of both diving and cold shock responses may precipitate supraventricular arrhythmias.
- Pleural fluid accumulation has been associated with drowning, the volume of which controversially being said to reflect the post-mortem interval.

CHAPTER (17): HEAT, COLD & ELECTRICAL TRAUMA

Introduction: Heat, cold and electricity are some of the ‘physical agents’ that can cause non-kinetic injuries to the body.

Injury caused by heat:



1. Burns: Can be classified by their severity (degree of burn injury and depth of tissue burned) and extent (burn area).

Severity of burn	1 st degree	Erythema and blistering (vesiculation)
	2 nd degree	Burning of the full-thickness of the epidermis and exposure of the dermis
	3 rd degree	Destruction down to subdermal tissues, sometimes with carbonization and exposure of muscle and bone
Extent of burn	The size of the area of burning may be more important in the assessment of the dangers of the burn than the depth. Body surface area affected by burns may be conveniently expressed as a percentage of the total body surface area using the ‘Rule of Nines’ .	

2. Scalds: The general features of scalds are similar to those of burns, with erythema and blistering, but charring of the skin is only found when the liquid is extremely hot, such as with molten metal.

<i>The way of exposure</i>	<i>Pattern of scalding</i>	<i>Example</i>
Immersion into hot liquid	Upper ‘fluid level’	
Splashed or scattered droplets of liquid	Scattered punctate areas of scalding	
Runs or dribbles of hot fluid	Generally flow under the influence of gravity and this can provide a marker to the orientation or position of the victim at the time the fluid was moving	Children pulling saucepans with hot liquid off a cooker.

Accidental vs. intentional scalds:

	Accidental	Intentional
Injury	'Spill' injuries from 'flowing liquid'	Forced immersion in hot water
Example	From hot beverages/liquids being pulled of a table top, etc.	Child physical abuse (the most common intentional thermal injury in children), when a child is placed in a tub or bath of hot water.
Characteristics	- Scalds with irregular margins and burn depth. - Lacking a 'glove and stocking' distribution.	Symmetrical 'glove and stocking' injuries to the limbs, sparing skin folds (and buttocks in those forced to sit in hot water), which are of uniform depth

Autopsy findings in 'heat illness' including 'heat stroke':

They are non-specific but can include:

1. Pulmonary and/or cerebral oedema.
2. Visceral surface petechiae.
3. Features in keeping with 'shock' and multiple organ failure in those who survive for a short period.

Pathological investigation of bodies recovered from fires

- **Safety of investigators** after events such as gas explosions is a very important consideration in the examination of fire scenes.
- The fire scene **must be examined by specialist investigators** with expertise in the interpretation of the causes and 'point of origin' or 'seat' of fires, and the use of accelerants, such as petrol.
- **Attendance at the scene by a pathologist is important** and assists subsequent interpretation of post-mortem findings.

The pathological investigation of bodies recovered from fires should attempt to:

1. **Confirm the identity of the deceased.**
2. **Determine whether the deceased was alive at some time during the fire (or was dead before it started).**
3. **Determine why the deceased was in the fire (and why they could not get out of it).**
4. **Determine the cause of death.**
5. **Determine (or give an opinion as to) the manner of death.**

Identification of bodies:

- Visual identification from facial features.
- Unique medical features and factors such as the presence of scars and tattoos,
- Dental examination and comparison of the dentition with available ante-mortem records.
- DNA analysis.

Post-mortem radiography should usually be performed before dissection, with particular emphasis on radiographs to assist identification (dentition, surgical prostheses, etc.), to identify fractures (including healing fractures with callus) and to exclude projectiles such as bullets and shrapnel.

Determination of 'vitality' (the fact that someone was alive) during the fire at post-mortem examination:

- 1) The finding of soot in the airways, oesophagus and/or stomach (the implication that respiration was required to inhale the soot), and may be confirmed under the microscope.
- 2) Blood samples for a rapid assessment of carboxyhaemoglobin (a level of over 50% often being considered good evidence of death having occurred as a consequence of breathing in the combustion products of fire)

Deaths occurring during a fire:

- **Determination of manner of death:** While the determination of 'manner of death' usually rests with the appropriate medico-legal authority, **an opinion from the forensic pathologist is frequently sought**. The interpretation of injury in bodies recovered from fire is complicated by artefacts related to exposure to fire:
 - The so-called 'pugilist attitude' of the body reflects differential heat-related contraction of muscle, leading to flexion of the forearms, hands and thighs.
 - Post-mortem splitting of fragile burnt skin
 - Fire- and heat-related fractures
 - Heat-related 'extradural haemorrhage', caused when severe heat has been applied to the scalp.

Examples of mechanisms of death in fires:

- Interference with respiration (owing to a reduction in environmental O₂ and/or the production of CO and other toxic substances)
- Inhalation heat injury leading to laryngospasm, bronchospasm and so-called 'vagal inhibition' and cardiac arrest
- Exposure to extreme heat and shock
- Trauma
- Exacerbation of pre-existing natural disease or burns

Cold injury (hypothermia):

- Cold injury (hypothermia) has both clinical and forensic aspects, as many people suffer from and die of hypothermia even in **temperate climates** in winter, in **marine disasters**.
- Hypothermia occurs when a person's body temperature below **35°C**.
- If a body gets cold, the normal response is to warm up by becoming more active, or moving indoors. If exposure to the cold **continues**, other physiological processes will attempt to prevent any further heat loss. These processes include **shivering** (tremble), **restricting blood flow** to the skin and **releasing hormones to generate heat**.
- The body may rapidly lose temperature when sinking in cold water, as water has a cooling effect that is 20-30 times that of dry air.
- Generally, the elderly, children and trauma patients are more susceptible to hypothermia. Hypothermia can be classified into mild (32-35°C), moderate (30-32°C), or severe (<30°C).

Features of Mild, moderate, severe hypothermia.		
Mild	Moderate	severe
<ul style="list-style-type: none">❖ shivering❖ feeling cold❖ lethargy❖ cold, pale skin	<ul style="list-style-type: none">❖ uncontrollable shivering❖ cognitive impairment❖ confusion❖ slurred speech	<ul style="list-style-type: none">❖ loss of control of hands, feet and limbs.❖ unconsciousness❖ irregular or no pulse❖ dilated pupils

- In an unrefrigerated body, the finding of indistinct red or purple skin discoloration over large joints. raises the possibility of hypothermia and is found in approximately 50% of presumed hypothermia deaths (Figure)



- The phenomenon of **'hide and die syndrome'** describes the finding of a body that appears to be hidden, for example under furniture or in the corner of a room, etc. It is thought that this phenomenon reflects a terminal primitive 'self protective' behavior and may be more commonly observed where there is a **slow decrease in core body temperature**.

Electrical injury:

- Injury and death from the passage of an electric current through the body is common. The essential factor in causing harm is the current (electron flow).
- Almost all of the cases, fatal or otherwise, originate from the public power supply, which is delivered throughout the world at either 110 V or 240 V. It is rare for death to occur at less than 100 V.
- The current needs an **entry point** (hand), and the **exit** is to earth (via the other hand or the feet). In either case, the **current will cross the thorax, which is the most dangerous area for a shock** because of the risks of cardiac arrest or respiratory paralysis.
- When a live metal conductor is gripped by the hand, pain and muscle twitching will occur if the current **10 mA**. If the current is **30 mA**, the muscles will go into spasm. If the current across the chest is **50mA** or more, fatal ventricular fibrillation is likely to occur.
- The tissue resistance is important. Thick **dry skin**, such as the palm of the hand or sole of the foot, may have a resistance of **1 million ohms**, but when **wet**, this may fall to a **few hundred ohms**.

Death from lightning:



- Hundreds of deaths occur each year from atmospheric lightning, especially in tropical countries. Huge electrical forces are involved, producing millions of amperes. Some of the lesions caused to those who are struck directly, but other will be from burns and from the ‘explosive effects’ of a compression wave of heated air leading to ‘burst eardrums’, pulmonary blast injury and muscle necrosis.
- The usual textbook description is of ‘fern or branch-like’ patterns, but others claim that such marks are not seen. Although many bodies are completely unmarked.

CHAPTER (18): PRINCIPLES OF TOXICOLOGY

TERM	DEFINITION	Notes
Toxic	To imply that ingestion of a particular substance will cause death Or some sort of illness.	
lethal dose	It represents the dose of a drug at which all subjects given the drug will die.	The dose is expressed in grams, micrograms or milligrams per kilogram.
Lethal Dosage (LD50)	The dose at which 50% of those who take a particular dose will die.	The LD50 depends partly on the mode of drug administration
Drug tolerance	Tolerance occurs after chronic exposure to a specific drug in which increasingly large doses of the drug produce less and less effect.	Dependence goes hand in hand with tolerance as they are controlled partly by receptor distribution, density and genetic makeup.
Drug dependence	Dependence is said to exist when an individual cannot function normally in the absence of a specific drug.	Tolerance determine if the drugs is the cause of death but cant be measured after death
Drug withdrawal	It is the development of symptoms when a drug is abruptly discontinued.(the drug must be taken in large quantities for a long time)	Only individuals who are already dependent on a drug can experience withdrawal symptoms.
Drug idiosyncrasies	This term is used to describe unanticipated drug reactions.	These reactions are allergic in nature (hypersensitivity reaction)
Drug interactions	This term describes unanticipated symptoms and signs that result after two or more different drugs have been given.	Interactions may be good or bad.

Testing matrices general principles:

- Detection of a drug proves ingestion or at least exposure, but its presence even in large quantities says nothing about toxicity or cause of death.

- Laboratory investigations can't supply sufficient information to a forensic investigation as history and examination
- Route of administration can't be measured by skin, vaginal, rectal and nasal swabs unless in skin for ex : taken from both sides of the body.
- The site of blood collection at autopsy may not determine the final analytical result + it's not reliable of its concentration during life.
- After death weak basic drugs (ex: cocaine) concentrations in the heart (left side more) higher than leg.

Specific Testing matrices:

- **Blood & Urine:** Blood is the preferred testing matrix (urine in the past) for drug detection (collected in a Na fluorinated tube to prevent further degradation). In death whole blood concentration is measured while in pre-mortem only plasma. Drugs concentrations especially Alcohol. Plasma ethanol concentrations are 10-15% higher than the whole blood.
- **Vitreous humor:** used to diagnose electrolyte disorder, renal failure, hyperglycemia and ethyl alcohol ingestion.
- **Hair testing:** for drug abused (info about drug exposure and compliance).
- **Liver analysis** (only left lobe): if the drug sought to be:
 1. Highly bound to proteins.
 2. Undergoes enterohepatic circulation or remain there so long.
- **Stomach:**
 - **Examine if:**
 1. The volume of the gastric content is recorded.
 2. Homogenous specimen.
 3. Total drug content within the stomach is computed.
 - Examination of the stomach gastric fluid microscopically to identify small pill fragments.
 - Detection of drugs in stomach doesn't indicate oral ingestion, and some drugs are present in the stomach although they're injected intravenously.

CHAPTER (19): ALCOHOL

General facts:

- **Blood alcohol concentration (BAC)** can be measured by **Winnek's formula**:
$$\text{BAC} = (150/\text{body weight in pounds}) (\% \text{ ethanol}/50) (\text{ounces consumed}) (0.025).$$
- Eg: If a 200-pound (90.7 kg) man drank five 12-ounce (354.9 mL) cans of beer, that contain 4% his BAC will be: $\text{BAC} = (150/200) (4/50) (60) (0.025) = 0.090\%$ (90 mg%).
- The **rate of absorption increase** by: High alcohol concentration.
- The **rate of absorption decrease** by: Food, High fluid volume, low alcohol concentration.
- **Alcohol metabolism**: Ethanol → Acetic acid → Acetaldehyde.
- **Acetaldehyde** is responsible for most of the clinical side effects of alcohol.
- The measured alcohol concentration depends on **both weight and sex** because these two factors determine the total volume of body water.
- **High total body water = Low alcohol concentration.**

Clinical effects of alcohol:

- Ethanol is a potent **central nervous system depressant**.
- Initial feelings of relaxation and cheerfulness give way to blurred vision, loss of coordination and behavioral issues.
- After excessive drinking, unconsciousness → **alcohol poisoning and death**.
- In case of severe intoxication, **vomit aspiration** may lead to asphyxiation & death.
- Chronic alcoholics are able to tolerate higher BAC than non-alcoholics.
- After death, **bacterial enzymes** act upon carbohydrates within the cadaver. Glycogen or lactate is converted to pyruvate and then ethanol.
- Postmortem ethanol production will be greater in some tissues than in others depending on the **amount of glycogen or substrate** available. (*e.g. postmortem ethanol production will be greater in liver compared to vitreous humour*).
- **Factors increase postmortem ethanol production**: High terminal hyperthermia, bowel trauma, severe body disruption (*trauma*), high glycogen/substrate amount.
- We compare the **ethanol content of urine (UAC)** and/or **vitreous humour** with the **amount measured in blood** to know whether alcohol detected was formed before or after death.

CHAPTER (23): PRINCIPLES OF FORENSIC SCIENCE

Locard's exchange principle: 'every contact leaves a trace'.

Scene examination: (to secure, identify and preserve evidence)

- A crime scene is a zone is cordoned off, within which all people accessing or leaving are entered into (and have to sign) a 'scene log'.
- Crime Scene Manager (CSM) is in overall charge of the scene.
- Scene of Crime Officers (SOCOs) is in charge of evidence gathering.
- Police Search Advisory (POLSA) staff in charge of 'fingertips'.
- If there are human remains at crime scenes, examinations are focused on the immediate area around the remains so that they can be removed for a post-mortem examination (why?) → remains are prone to rapid changes, especially during the first few weeks.

Evidence recovery:

- 1- Evidence assigned an exhibit number.
- 2- Photographed before removed
- 3- Packaged. Packaging differ based on the evidence:

Paper sacks	For clothing because, if item is slightly damp, this allows moisture to pass through.
Plastic bags	For items such as cigarette ends.
Plastic tubes/ weapons tubes	For sharp items such as knives or screwdrivers.
Cardboard boxes	With plastic ties to secure the item in place (for sharp items).

- Exhibit label integral with the package for item details signed by person who seized it.

Chain of custody:

- Each time it is transferred from one place to another, the details need to be recorded.
- Continuity forms, tells that the exhibit has been passed from one person to another.
- Once examinations of an exhibit have been concluded, it is retained for a period of time before it is destroyed or, on occasion, returned. But, often not destroyed.

Sample analysis:

○ DNA analysis:

First step→ dissolve the sample in appropriate chemicals to ensure the maximum amount of DNA can be recovered.

Second step→ carried out so that the correct amount of the extracted sample is removed for the next step.

Third step→ Amplification is carried out using the polymerase chain reaction (PCR), which uses an enzyme-catalysed reaction over a number of cycles.

○ Body fluid analysis:

Blood: Leucomalachite Green (LMG) or Kastle-Meyer (K-M) both filtered by hydrogen peroxide. If color changes to green for LMG, pink for K-M when blood has a peroxidase like activity from hemoglobin (=confirmed blood stain).

Semen: acid phosphatase (AP) test, purple color develops (=confirmed semen)

Saliva: Phadebas test detects the presence of amylase. Blue color (=confirmed saliva).

'Touch' DNA: depositing skin cells, used to assist in the identification of wearers of garments such as gloves.

Urine: dimethylaminocinnamaldehyde (DMAC) test to detect the presence of urea. Chemical creatinine test, another constituent of urine.

Faeces: Edelman's test, which detects the presence of urobilinogen.

Blood pattern analysis:

Downward drips	Flat surface→ characteristic circular stain Absorbent surface→ much smaller, same volume
Contact blood staining	Contact bloodstains are formed when a blood-stained item comes into contact with another, non-stained item.
Impact spatter	When someone is struck in an area that bears wet blood staining the stains can be broken up and projected away from the area of impact.
Cast-off	When an item bearing blood staining is moved through the air with sufficient force to drive blood from its surface.
Arterial spurting	When an artery is damaged blood is projected under high pressure, which does not happen with venous bleeding.
Physically altered blood stains	Physically altered <u>over time</u> or by the <u>addition of other body fluid</u> .
Luminol	Highly sensitive chemiluminescent compound can help the scientist visualize where blood staining had been present before any such cleaning efforts.

Damage:

Using controlled tests and reconstructions, it is also possible to comment on whether or not a specific item or action caused an area of damage.

Fingerprints:

- The theory that fingerprints are unique to each person that enabled them to become one of the primary methods of identification.
- The overall nature of a fingerprint can be described as loops, whorls or arches
- sweat glands within the ridges, an impression of these secretions can be left as a fingerprint on a surface (latent marks).
- Fingerprints may also be left (patent marks) if there is a contaminant such as ink, blood or paint.
- Scanning the fingerprints with the database to find the suspects.

Footwear:

Footwear marks: depend on many factors, such as how dirty the sole of the shoe is or the floor surface itself. Examination of footwear involves comparing the sole pattern, size and degree of wear in the mark found at a scene with a test mark made from an item of footwear.

Footwear marks and skin: When contact is made with a person with a degree of force, by kicking or stamping, then skin deposits may be transfer.

Trace evidence:

Glass: broken glass fragments would transfer to the individual. Length of time that these glass fragments remain on clothing would depend on many factors, such as the type of clothing and the activity of the individual.

Paint: If damage is caused to a painted surface then small flakes can be transfer. Each type of paint may be discriminated by its colour, texture and composition.

Fibres: based on certain characteristics enable the forensic fibre examiner to identify sources of fibres.

Firearms: Two main types of firearm:

- **Smooth-bore barrels**, which usually fire groups of shot (Shotguns).
- **Rifled barrels**, which usually fire single bullets (hand guns and rifles).

CHAPTER (24): ALLIED FORENSIC SPECIALTIES

Forensic ecology is the use of environmental evidence types to assist in investigating crime, both outdoors and indoors. It consists of diatomology, palynology and entomology.

1. **Diatomology:** Diatoms are algae, microscopic unicellular plants, which can be found in saltwater, freshwater, soils and damp surfaces. When diatoms die, their skeletons sink to the bottom layers of water. By extracting diatoms from organs that have been collected under the correct conditions to protect against contamination, the scientist can comment on whether or not drowning contributed to death.
2. **Forensic palynology** uses analysis of pollen, spores and other microscopic particles. **Pollen** is seasonally and geographically sensitive.
3. **Forensic entomology** is the application of knowledge about insects to assist in legal investigations, the vast majority of which are suspicious deaths or murders. The most commonly encountered insects are **blowflies**, but other flies and beetles are often found.

USES	
Pollen evidence	Link people, vehicles, and objects to a known scene or deposition site.
	Identify habitats or geographical locations relevant to police investigations.
	Prove or disprove alibis.
	Assist in determining the season and location in which an individual died.
	Help determine possible locations of a missing person by looking at the clothing of a suspected offender.
	Help determine the fate of an individual prior to death.
Insect analysis	An estimated post-mortem interval (PMI).
	Whether or not a body has been moved from one location to another.
	Whether a body has been moved between a concealed and exposed environment.
	Whether there has been abuse and neglect.
	Whether there are public health issues.

Forensic archaeology is concerned with the **location, recovery and interpretation of buried evidence**, mostly human remains, and associated items that may be within the grave, as well as buried items such as stolen goods, firearms and drugs. The forensic archaeologist will use their knowledge of land surface characteristics to determine whether or not there could be a burial site.

Forensic anthropology is the study of the **biological and cultural aspects of humans**. Initially identifying human remains in the medicolegal setting. Once bones have been identified as human, the forensic anthropologist will attempt to establish a biological profile of the individual, or individuals. Depending on the completeness of the remains, this may include **sex, age at death, height and possible ethnicity**. Age estimation is a complex area and the anthropologist is well placed to be part of a team that may include physicians, odontologists and radiologists.

Forensic odontology is practiced by those initially trained as dentists. Forensic odontologists **apply their dental skills in the forensic setting** and are key players in human **identification** (of the living and deceased), **ageing** (of the living and the deceased) and in the identification and interpretation of **bite marks**. Odontologists attempt to identify dental patterns and features and compare these either with known ante-mortem information about the individual.

Forensic photography is a very specialized area embracing a range of imaging techniques that allow best presentation of visually relevant evidence in an appropriate format. Forensic photographic techniques can include **the use of ultraviolet, infrared and polarized light photography**, which can be used to enhance or identify items or injuries of interest.

APPENDIX (1): GUIDELINES FOR AN AUTOPSY AND EXUMATION

Guidelines:

1. Where the death is definitely due to crime or if there is a possibility of crime, the doctor should attend the scene before body is moved (Notes on the scene and photographs are taken).
2. The identity of the body should be confirmed to the doctor.
3. If the remains are mummified, skeletalized, decomposed, burnt or disfigured to a point at which visual identification is impossible, other methods of establishing the identity should be used.
4. In a suspicious death, the body should be examined with the clothing in place so that defects caused by trauma that may have damaged the body (stab wounds, gunshot injuries, etc.) can be identified.
5. The body should be **photographed clothed and then unclothed** and then any injuries should be photographed in closer detail.
6. **X-rays** are advisable in victims of gunshot wounds and explosions and where there is a possibility of retained metal fragments, and are mandatory in all suspicious deaths in children.
7. The **surface of the body** should be examined for the presence of trace evidence (fibres, hair, blood, saliva, semen) performed by **police officers or by forensic scientists**, often with the assistance of the pathologist. Where samples are to be **removed from the body itself** as opposed to the surface of the body - fingernail clippings, head and pubic hair, anal and genital swabs - these should be taken by the **pathologist**.
8. Careful documentation of the **external features of injuries**, their position, size, shape and type is the **most important aspect of a forensic examination** and much greater value than the internal dissection of any wound tracks or of damaged internal organs.
9. The internal examination must fulfill **two requirements**: to identify and document **injuries** and to identify and document **natural disease**.
10. Samples of **blood** should be collected from a large limb vein, preferably the **femoral vein**, and **urine** should be collected, preferably using a clean syringe, through the **fundus of the bladder**.
11. Tissue samples should be retained in formalin for microscopic examination.

The autopsy:

1. An incision is made from the **larynx to the pubis**. The upper margin may be extended on each side of the neck to form a '**Y**' incision.
2. The skin on the front of the chest and abdomen is reflected laterally and the anterior abdominal wall is opened. The **intestines** are removed by cutting through the **third part of the duodenum**. Then dissecting the small and large bowel from the **mesentery**.
3. The ribs are sawn through in a line from the lateral costal margin to the inner clavicle and the front of the chest is removed.
4. The iliac vessels and the ureters can be bisected at the level of the pelvic rim.
5. The pelvic organs are examined in situ or they can be removed from the pelvis for examination.
6. The scalp is incised **coronally**.
7. Orders in organ dissection: tongue, carotid arteries, oesophagus, larynx, trachea, thyroid, lungs, great vessels, heart, stomach, intestines, adrenals, kidneys, spleen, pancreas, gall bladder and bile ducts, liver, bladder, uterus and ovaries or testes and finally the brain.

تم بحمد الله ~

إن أصبنا فمن الله، وإن أخطأنا فمن أنفسنا والشيطان