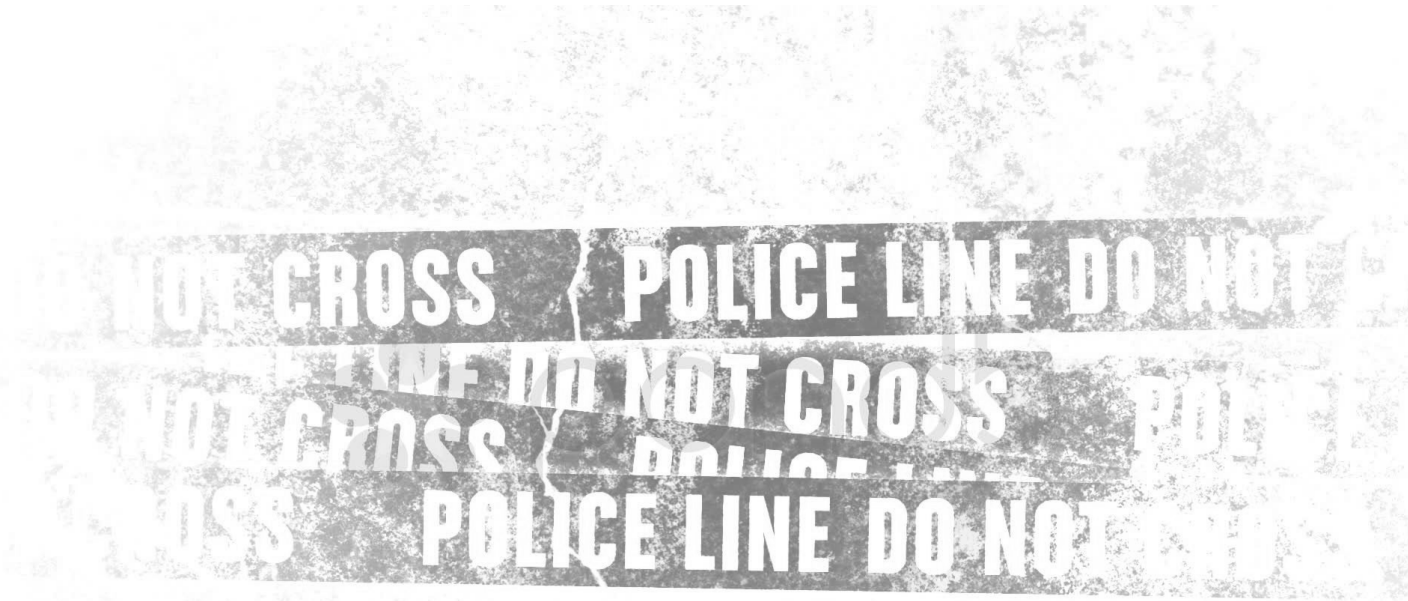

Identification, PM Changes

Chapters 4 and 5

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Correction file

Chapter 4

Identification of the living and the dead

Proper identification of a body is a task for a multi-professional team that includes the forensic pathologist, forensic odontologist, anthropologist, and radiologist. Identification 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. If decomposition or post-mortem changes are advanced then visual identification may not be possible and other techniques may be required to confirm identify. If there is substantial injury (e.g. in aircraft crashes or bombings) or deliberate mutilation other techniques will be required to establish identity.

Methods of identification:

Identification criteria:

Identification criteria may be termed primary or secondary, with a third group assisting in identification.

- ★ Primary identification criteria: fingerprints, DNA, dental and unique medical characteristics.
- ★ Secondary criteria: features such as deformity, marks and scars, X-rays, personal effects and distinctive clothing.

The first thing to use in identification is facial recognition.

1) DNA profiling:

It is great in statistical terms that it can be reliably specific to any individual. Only about 10% of the molecule is used for genetic coding (the active genes), the remainder being 'silent'. In these silent zones, there are between 200 and 14000 repeats of identical sequences of the four bases – adenine, thymine, cytosine and guanine –. Jeffreys found that adjacent sequences were constant for a given individual and thus can be used in identification. There is now no need to match blood with blood and semen with semen, as all the DNA in one individual's body must of necessity be identical.

Note: Scene examination must be carefully approached and with sufficient protective clothing to prevent the investigators obscuring any relevant DNA by their own material being inadvertently shed from exposed skin, or by sneezing.

2) Examination of dental structures:

Neither the living nor the dead can be identified simply by taking a dental chart –that chart has to be compared with, and found to match, a chart whose origins are known-. The forensic odontologist is of prime importance in mass disasters where trauma makes identification impossible. 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[1].

Retained dentation after fire.

3) Fingerprints:

Often obtained from desquamated skin or from the underlying epidermis after shedding of the stratum corneum following prolonged submersion. -By the gloving technique-

[1] the disposal of a dead person's body by burning it to ashes, typically after a funeral ceremony.

4) Morphological characteristics:

The finding of a unique medical feature, or a combination of specific features, that is known to be possessed by that individual alone will add considerable weight to the conclusions. In both the living and dead, the height, weight and general body type need to be recorded and compared. Tattoos, surgical scars, old injuries, congenital deformities, striae from childbirth, tribal scars or markings, circumcision, moles, warts and other skin blemishes, etc., must be carefully recorded and photographed because a relative, friend or doctor may be able to confirm an identity from these features.

Tattoos and body piercings

- The main use of tattoos and piercings in forensic medicine is in the identification of the bodies of unknown persons. Ante-mortem images can be very helpful when compared with images of the deceased, which can be used if a visual identification is not possible or so that they can be circulated when the identity is not known. Decomposing bodies should be examined carefully for tattoos, which may be rendered more visible when the superficial desquamated stratum corneum is removed.

- Body piercing site and type should be noted and piercings can be used as part of visual identification or can be recovered for identification by relatives.

Mass disasters:

At the time it may not be known whether an event has happened by accident, natural disaster or as a crime. Ante-mortem data from potential decedents, including dental, fingerprint and DNA samples should be sought at the earliest opportunity for later comparison.

Identity of decomposed or skeletalized remains:

A panel of pathologists, anthropologists, odontologists, radiologists and scientists should ask themselves the following questions:

- **Are the remains actually bones?**
  Sometimes stones or even pieces of wood are mistaken for bones. the anatomical shape, character and texture should be obvious to a doctor.
- **Are the remains human?**
  A forensic pathologist will be able to identify almost all of the human skeleton, although phalanges, carpal and tarsal and fragmented bones can be extremely difficult to positively identify as human and the greater skills and experience of an experienced anthropologist or anatomist are invaluable. Cremated (burned to ashes) bones pose difficulties and these should only be examined by specialists.
- **Am I dealing with one or more bodies (is there co-mingling of body parts)?**
  This question can be answered very simply if there are two skulls or two left femurs. However, if there are no obvious duplications, it is important to examine each bone carefully to assess whether the sizes and appearances match. It can be extremely difficult to exclude the possibility of co-mingling of skeletal remains, and expert anthropological advice should be sought if there is any doubt.
- **What sex are the bones?**
  The skull and the pelvis offer the best information on sexing; although the femur and sternum can provide assistance, they are of less direct value. It is important to attempt to determine the sex of each of these bones and not to rely on the assessment of just one. Examination by an anthropologist or anatomist is vital.

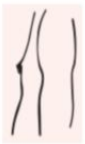
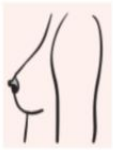
Identity of Decomposed or Skeletalized Remains Continued:

- **What is the age of the person?**
  This requires a multi-professional approach of the pathologist, anthropologist, odontologist and radiologist, each contributing to the overall picture.
- **What is the height (stature) of the person?**
  The head to heel measurement of even a completely fresh dead body is not always the same as the person's standing height in life, owing to a combination of factors, including muscle relaxation and shrinkage of intervertebral discs. If a whole skeleton is present, an approximate height can be obtained by direct measurement but, because of variable joint spaces, articular cartilage, etc., this can only be, at best, an approximation. If only some bones are available, calculations can be made from established tables.
- **What is the race or ethnic origin?**
  This is determined by a trained anthropologists and should not be attempted without their assistance.
- **Can a personal identity be discovered?**
  The previous criteria can allot bones to various groups of age and sex but putting a name to the individual depends, as does all identification, upon having reliable ante-mortem data. Occasionally, foreign bodies such as bullets or other metallic fragments may be found embedded in the skeleton; these 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.

Age Estimation in the Living:

In external estimation of age we should use Tanner staging to assess child maturity. Skeletal estimation will assess hand/ wrist radiographs in the first instance, which are compared against standards previously published. A visual intraoral inspection will inform the practitioner as to the stage of emergence and loss of the dentition and is particularly useful for age evaluation in the pre-pubertal years. Pubertal and post-pubertal individuals will, however, require a radiographic investigation.

Stage	G = genitals (boys)		B = breasts (girls)		P = pubic hair (girls)	
1		Pre-adolescent		Pre-adoloscent		No hair
2		Scrotum pink and texture change, slight enlargement of the penis		Breast bud		Few fine hairs
3		Longer penis larger testes		Larger, but no nipple contour separation		Darkens, coarsens, starts to curl
4		Penis increases in breadth, dark scrotum		Areola and pailla from secondary mound. Menarche usually commeneces at this stage		Adult type, smaller area
5		Adult size		Mature (pailla projects, areola follows breast contour)		Adult type

IMP.

Chapter 5

The appearance of the body after death

Initially, changes can only be detected biochemically as the metabolism in the cells alters to autolytic pathways. Eventually, the changes become visible and these visible changes are important for two reasons: first, because a doctor needs to know the normal progress of decomposition so that he does not misinterpret these normal changes for signs of an unnatural death and, second, because they may be used in estimating how long the individual has been dead (i.e. the post-mortem interval, or PMI).

The Early Post-mortem Interval:

Rapid changes after death:

★ Initially, the cells that can use anoxic pathways will do so until their metabolic reserves are exhausted, and then their metabolism will begin to fail.

★ With loss of neuronal activity, all nervous activity ceases, the reflexes are lost and breathing stops. In the eye the corneal reflex ceases and the pupils stop reacting to light.

★ The muscles rapidly become flaccid, with complete loss of tone. Discharges of the dying motor neurons may stimulate small groups of muscle cells and lead to focal twitching, although these decrease with time. -Loss of muscle tone may result in voiding of urine. Emission of semen is also found in some deaths; therefore, the presence of semen cannot be used as an indicator of sexual activity shortly before death-.

★ Regurgitation of gastric contents is a very common feature of terminal collapse and it is a common complication of resuscitation. Gastric contents are identified in the mouth or airways in a significant proportion of all autopsies.

★ The fall in blood pressure and cessation of circulation of the blood usually render the skin, conjunctivae and mucous membranes pale. The skin of the face and the lips may remain red or blue in colour in hypoxic/congestive deaths. The hair follicles die at the same time as the rest of the skin and there is no truth in the belief that hair continues to grow after death.

Rigor Mortis:

- Rigor mortis is a temperature-dependent physicochemical change that occurs within muscle cells because of lack of oxygen. The lack of oxygen means that energy cannot be obtained from glycogen via glucose using oxidative phosphorylation and so adenosine triphosphate (ATP) production from this process ceases and the secondary anoxic process takes over for a short time but, as lactic acid is a by-product of anoxic respiration, the cell cytoplasm becomes increasingly acidic.
- In the face of low ATP and high acidity, the actin and myosin fibers bind together and form a gel. The outward result of these complex cellular metabolic changes is that the muscles become stiff. However, they do not shorten unless they are under tension.
- Rigor 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 appears to advance down the body from the head to the legs as larger and larger muscle groups become stiffened.

- The chemical processes that result in the stiffening of the muscles are affected by temperature: the colder the temperature the slower the reactions and vice versa.
- In temperate conditions rigor, can commonly be detected in the face between approximately 1 hour and 4 hours and in the limbs between approximately 3 hours and 6 hours after death, with the strength of rigor increasing to a maximum by approximately 18 hours after death. Once established, rigor will remain for up to approximately 50 hours after death until autolysis and decomposition of muscle cells intervenes and muscles become flaccid again. These times are only guidelines and can never be absolute.

It is best to test for rigor across a joint using very gentle pressure from one or two fingers only; the aim is to detect the presence and extent of the stiffness, not to 'break' it.

Post-mortem hypostasis:

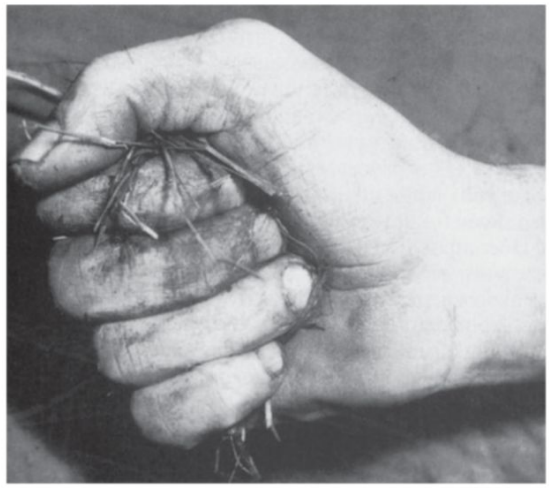
Cessation of the circulation and the relaxation of the muscular tone of the vascular bed allow simple fluid movement to occur within the blood vessels. Post-mortem hypostasis or post-mortem lividity are the terms used to describe the visual manifestation of this phenomenon.
The passive settling of red blood cells under the influence of gravity to blood vessels in the lowest areas of the body is of forensic interest. This results in a pink or bluish colour to these lowest areas and it is this colour change that is called post-mortem hypostasis or lividity.
The site and distribution of the hypostasis must be considered in the light of the position of the body after death. A body left suspended after hanging will develop deep hypostasis of the lower legs and arms, with none visible on the torso, whereas a body that has partially fallen head first out of bed will have the most prominent hypostatic changes of the head and upper chest.

- Hypostasis is not always seen in a body and it may be absent in the young, the old and the clinically anaemic or in those who have died from severe blood loss. It may be masked by dark skin colours, by jaundice or by some dermatological conditions.

- Changes in the position of a body after the initial development of hypostasis will result in redistribution of the hypostasis and examination of the body may reveal two overlapping patterns.

Cadaveric rigidity: The doctor says t's a rare incident just forget about it!

'Cadaveric rigidity' is said to be the stiffness of muscles that has its onset immediately at death, it is suggested that the mechanism for this phenomenon is possibly neurogenic, but no scientifically satisfactory explanation has been given. It is clearly not the same chemical process as true rigor and it is better that the term 'instantaneous rigor' is no longer used as it implies an equivalence with a process for which there is a scientific explanation.



Cooling of the body after death:

This can be viewed as a simple physical property of a warm object in a cooler environment. 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. However, a body is not a uniform structure: its temperature will not fall evenly and, because each body will lie in its own unique environment, each body will cool at a different speed, depending upon the many factors surrounding it. Many other variables and factors also affect the rate of cooling of a body (Box 5.1) and that's why the sensible forensic pathologist will be reluctant to pronounce time of death based on the body temperature alone.

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

As the post-mortem interval increases, the body undergoes additional changes that reflect tissue 'breakdown', autolysis and progressive decomposition/ putrefaction.

Decomposition/putrefaction:

- The early changes of decomposition are important because they may be confused by the police or the public with the signs of violence or trauma
- Decomposition results in liquefaction of the soft tissues over a period of time, the appearance of which, and the rate of progress of which is a function of the ambient temperature: 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.
- Blood vessels provide an excellent channel through which the bacteria can spread with some ease throughout the body. Their passage is marked by the decomposition of haemoglobin which, when present in the superficial vessels, results in linear branching patterns of skin discoloration called 'marbling'.
- Considerable gas formation in soft tissues and body cavities is common and the body begins to swell, with bloating of the face, abdomen, breasts and genitals. The increased internal pressure causes the eyes and tongue to protrude and forces blood-stained fluid up from the lungs which often 'leaks out' of the mouth and nose as 'purge fluid'.

As decomposition continues, soft tissues liquefy; however, the prostate and the uterus are relatively resistant to putrefaction and they may survive for months, as may the tendons and ligaments.

"Marbling of the dead".

Immersion and burial:

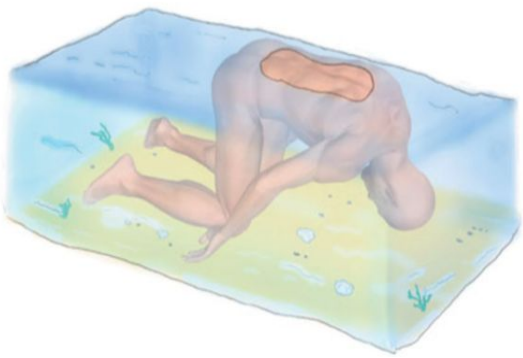
Immersion in water or burial will slow the process of decomposition. Casper's Law (or Ratio) states that: if all other factors are equal, then, when there is free access of air, a body decomposes twice as fast than if immersed in water and eight times faster than if buried in earth.

- The first change that affects the body in water is the loss of epidermis.
- Exposure to water can (in some cases) predispose the formation of adipocere, but it's unusual unless a body lies underwater for many weeks.

Adipocere:

A chemical change of body fat, which is hydrolyzed to a waxy compound like soap. The need for water means that this process is most commonly seen in bodies found in wet conditions (i.e. submerged in water or buried in wet ground).

- In the early stages of formation, adipocere is a pale, rancid, greasy semi-fluid material with a most unpleasant smell.
- As the hydrolysis progresses, the material becomes more brittle and whiter
- When fully formed, adipocere is a grey, firm, waxy compound that maintains the shape of the body.
- All three stages of adipocere formation can coexist and they can also be found with areas of mummification and putrefaction if the conditions are correct.



"Typical position of dead bodies in water"

"Following burial for 3 years, waxy adipocere forms a shell around the skeleton of this infant".

Skeletalization:

The speed of skeletalization will depend on many factors, including the climate and the microenvironment around the body. It will occur much more quickly in a body on the surface of the ground than in one that is buried.

Post-mortem injuries:

- Predation by land animals and insects can cause serious damage to the body: if there is any doubt about bite marks, an odontologist should be consulted. In water, fish, crustaceans and larger animals can also cause severe damage, but there is the added damage caused by the water-logging of the skin and the movement of the body across the bottom or against the banks. It is not true to say that post-mortem injuries do not bleed because many do leak blood, especially those on the scalp and in bodies recovered from water.
- The confirmation of a post mortem wound may be extremely difficult because injuries inflicted in the last few minutes of life and those that were caused after death may appear exactly the same. In general, post-mortem injuries do not have a rim of an early inflammatory response in the wound edges, but the lack of this response does not exclude an injury inflicted in the last moments of life.

Post-mortem animal predation. The wound margins of these rat bites are free from haemorrhage or reddening. Such injuries are commonly present around the eyes, ears and nose.

Mummification:

A body lying in dry conditions, either climatic or in a microenvironment, may desiccate(dehydrate) instead of putrefy – a process known as mummification. Mummification is much more likely in the thin individual whose body will cool and desiccate quickly. Mummification will not affect the whole body, and some parts may show the normal soft tissue decomposition changes, skeletalization or formation of adipocere, depending on the conditions. Mummified tissues are not immune to degradation and invasion by rodents, beetles and moths, especially the brown house moth, in temperate climates.

Estimation of the Post-mortem Interval:

The pathologist is often asked for an opinion on PMI (the 'time since death'). the most reliable would appear to be related to the cooling of the body after death (Rigor Mortis). (estimation of the time of death is becoming more academic and we should avoid pinpointing the exact time of death (ignore the estimation of death graphs in the book). Time of death is calculated from -the last time someone saw the person alive to the time his dead body was discovered) Dr-Khaldoon.

- Forensic entomologist, who can determine a probable time of death from examination of the populations and stages of development of the various insects that invade a body. Initially, the sarcophagus flies – the bluebottle (*Calliphora*), the greenbottle (*Lucilla*) and houseflies (*Musca*) – lay their eggs on moist areas, particularly the eyes, nose, mouth and, if exposed, the anus and genitalia. Other animals, both large and small, will arrive to feed on the body, with the species and the rapidity of their arrival depending on the time of year and the environment.
- The examination of buried bodies or skeletal remains will usually require the combined specialist skills of the forensic pathologist, an anthropologist and an entomologist.
- Forensic mycology, the assessment of fungi, is the other area where some assistance may be gained in determining the time of death in some cases.