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LEDARES

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Chapter 3

The medical aspects of death

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- Definition of death
- Cause of death determination and certification
- Medico-legal investigation of death
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CRIME SCENE - DO NOT CROSS CRIME

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Introduction

All doctors encounter death, and the dying, at some time in their medical career, and must have an understanding of the medical and legal aspects of these phenomena

Definition of death

Only organisms that have experienced life can die, as death represents the cessation of life in a previously living organism. Medically and scientifically, death is not an event; it is a process in which cellular metabolic processes in different tissues and organs cease to function at different rates.

This differential rate of cellular death has resulted in much debate – ethical, religious and moral – as to when ‘death’ actually occurs. The practical solution to this argument is to consider the death of a single cell (cellular death) and the cessation of the integrated functioning of an individual (somatic death) as two separate aspects.

Cellular death

Cellular death means the cessation of respiration (the utilization of oxygen) and the normal metabolic activity in the body tissues and cells. Cessation of respiration is soon followed by autolysis and decay, which, if it affects the whole body, is indisputable evidence of true death. The differences in cellular metabolism determine the rate at which cells die and this can be very variable – except, perhaps, in the synchronous death of all of the cells following, for example, a nearby nuclear explosion.

Skin and bone will remain metabolically active and thus ‘alive’ for many hours and these cells can be successfully cultured days after somatic death. White blood cells are capable of movement for up to 12 hours after cardiac arrest – a fact that makes the concept of microscopic identification of a ‘vital reaction’ to injury of doubtful reliability. The cortical neuron, on the other hand, will die after only 3–7 minutes of complete oxygen deprivation. A body dies cell by cell and the complete process may take many hours.

Somatic death and resuscitation

Somatic death means that the individual will never again communicate or deliberately interact with the environment. The individual is irreversibly unconscious and unaware of both the world and their own existence. The key word in this definition is ‘irreversible’, as lack of communication and interaction with the environment may occur in a variety of settings such as deep sleep, under anaesthesia, under the influence of drugs or alcohol or as a result of a temporary coma.

There is no statutory definition of death in the United Kingdom but, following proposed ‘brain death criteria’ by the Conference of Medical Royal Colleges in 1976, the courts in England and Northern Ireland have adopted these criteria as part of the law for the diagnosis of death.

The Academy of Medical Royal Colleges has published a code of practice for the diagnosis of death, stating that ‘death entails the irreversible loss of those essential characteristics which are necessary to the existence of a living human person and, thus, the definition of death should be regarded as the irreversible loss of the capacity to breathe.’

Criteria for the diagnosis and confirmation of death are specified following cardiorespiratory arrest, in a primary care setting and in hospital, and following irreversible cessation of brain-stem function, where specified conditions have been fulfilled (see Boxes 3.1–3.3).

Advances in resuscitation techniques in ventilation and in the support of the unconscious patient have resulted in the survival of patients that would otherwise have died as a result of direct cerebral trauma or of cerebral hypoxia from whatever cause

Previously, brain-stem death would lead inexorably to respiratory arrest and this would cause myocardial hypoxia and cardiac arrest. Artificial ventilation breaks that chain and while ventilation is continued, myocardial hypoxia and cardiac arrest are prevented

There is a spectrum of survival: some will recover both spontaneous respiration and consciousness, others will never regain consciousness but will regain the ability to breathe on their own and some will regain neither consciousness nor the ability to breathe and will require permanent artificial ventilation to remain ‘alive’.

Box 3.1 Criteria for the diagnosis and confirmation of death following cardiorespiratory arrest

- Simultaneous and irreversible onset of apnoea and unconsciousness in the absence of the circulation, following ‘full and extensive attempts’ at reversal of any contributing causes of cardiorespiratory arrest
- One of the following applies:
 - criteria for not attempting cardiopulmonary resuscitation (CPR) are fulfilled, or
 - CPR attempts have failed, or
 - life-sustaining treatment has been withdrawn, where a decision has been made that such treatment is not in the patient’s best interest, or where there is an ‘advance decision’ from the patient to refuse such treatment
- The person responsible for confirming death observes the individual for a minimum of 5 minutes, ensuring an absence of a central pulse on palpation and an absence of heart sounds on auscultation
- In a hospital setting, supplementary ‘evidence’ of death may be provided in the form of asystole on a continuous electrocardiogram (ECG) display, absence of contractile activity using echocardiography or absence of pulsatile flow using direct intra-arterial pressure monitoring
- Confirmation of the absence of pupillary responses to light, of the corneal reflexes and any motor response to supra-orbital pressure
- The time of death is recorded when these criteria have been fulfilled

Adapted from Academy of Medical Royal Colleges (2008) *A Code of Practice for the Diagnosis and Confirmation of Death. Report of a Working Party*, London.

Box 3.2 Criteria for the diagnosis of death following irreversible cessation of brain-stem function (adults and children over the age of 2 months)

- Absence of brain-stem reflexes:
 - pupils are fixed and do not respond to changes in light intensity
 - corneal reflex is absent
 - oculovestibular reflexes are absent when ice-cold water is introduced into the ear canals
 - no motor responses within the cranial nerve distribution can be elicited by stimulation of any somatic area
 - no cough reflex response to bronchial stimulation by a suction catheter placed in the trachea down to the carina
 - no gag response to stimulation of the posterior pharynx with a spatula
 - no spontaneous respiratory response following disconnection from the ventilator (‘apnoea test’), where arterial blood gas sampling confirms an increase in PaCO₂ by more than 0.5 kPa above the starting level
- Brain-stem testing should be made by at least two medical practitioners, registered for more than 5 years, and who are competent in the interpretation of such tests; at least one of these individuals must be a consultant
- Ancillary investigations – cerebral angiography, perfusion and neurophysiological – may be appropriate in some circumstances; brain-stem tests cannot be performed, for example, where there are extensive maxillofacial injuries

Adapted from Academy of Medical Royal Colleges (2008) *A Code of Practice for the Diagnosis and Confirmation of Death. Report of a Working Party*, London.

Box 3.3 Conditions necessary for the diagnosis and confirmation of death following irreversible cessation of brain-stem function

- Irreversible brain damage resulting from damage of known aetiology or, following continuing clinical observation and investigation, there is no possibility of a reversible or treatable underlying cause being present
- Potentially reversible causes of coma have been excluded
- There is no evidence that the state is caused by depressant drugs, for example narcotics, hypnotics or tranquillizers; specific antagonists may need to be used
- Hypothermia as the cause of unconsciousness has been excluded
- Potentially reversible circulatory, metabolic and endocrine disturbances have been excluded as the cause of the continuation of unconsciousness, including hyperglycaemia or hypoglycaemia
- Potentially reversible causes of apnoea have been excluded, for example the effects of neuromuscular blocking agents

Adapted from Academy of Medical Royal Colleges (2008) *A Code of Practice for the Diagnosis and Confirmation of Death. Report of a Working Party*, London.

Causes of death determination and certification

When deciding on what to ascribe an individual's death to, the doctor is making a judgement about causation, which may be relatively straightforward in an individual who has a documented history of ischemic heart disease and who experiences a cardiac arrest in hospital while on a cardiac monitor. Difficulties arise, for example, where an individual suffers a traumatic event, but has severe underlying natural disease, or where there are many potentially fatal conditions, each capable of providing an explanation for death at that time.

The degree of certainty with which the doctor is required to decide the cause of death may vary between jurisdictions, and it may be more 'intellectually honest' to provide the cause of death determination in a more 'narrative' style, such as is increasingly seen in Coroners' verdicts at inquests in England and Wales.

The law relating to causation is complex, varies between jurisdictions and is a subject outside the scope of this book. However, common themes in this area of law are that 'the cause' is something that is 'substantial and significant' (i.e. it is sufficient to have caused death), and that the outcome would not have occurred 'but for' the occurrence of the illness, disease or alleged action/omission of another person (i.e. it was necessary for such illness or other factor to have occurred for the outcome to be fatal).

In general, if a doctor knows the cause of death, and that cause of death is 'natural' (without any suspicious or unusual features), they may issue a certificate of the medical cause of death (commonly called a 'death certificate'). Which doctor may do this varies: in some countries the doctor must have seen and treated the patient before death, whereas in other countries any doctor who has seen the body after death may issue a certificate.

The format for certifying the cause of death is now defined by the World Health Organization (WHO) and is an international standard that is used in most countries. The system divides the cause of death into two parts: the first part (Part I) describes the condition(s) that led directly to death; Part II is for other conditions, not related to those listed in Part I, that have also contributed to death.

Part I is divided into subsections and generally three – (a), (b) and (c) – are printed on the certificate. These subsections are for disease processes that have led directly to death and that are causally related to one another, (a) being caused by or is a consequence of (b), which in turn is caused by or is a consequence of (c), etc. It is important to realize that, in this system of death certification, it is the disease lowest in the Part I list that is the most important, and as it is the primary pathological condition in the 'chain of events' leading to death. It is this disease that is most important statistically and which is used to compile national and international mortality statistics. Doctors should not record the mode of death (e.g. coma, heart failure) in isolation on the death certificate but, if a mode is specified, it should be qualified by indicating the underlying pathological abnormality leading to that mode of death. For example:

Ia Cardiac failure

Ib Hypertrophic cardiomyopathy

or

Ia Coma

Ib Subarachnoid haemorrhage

Ic Ruptured congenital aneurysm

Some jurisdictions will allow specific causes of death that would not be acceptable elsewhere. In the UK it is acceptable in certain situations, i.e. if the patient is over 80 years of age, to record '**Ia**: Old age'.

At the other end of the age range, the diagnosis of sudden infant death syndrome (SIDS) is now well established; unfortunately, the diagnostic criteria are seldom as well known and even less frequently are they applied to the letter.

The utility of the second part of the death certificate is perhaps questionable, and has a tendency to be used as something of a 'dustbin' to record all, many or some of the diseases afflicting the patient at the time of death, regardless of their causative role in that death. Guidance for doctors completing medical certificates of the cause of death has been produced by the Office for National Statistics.

The reliability of the information contained within the death certificate depends wholly on the integrity and competency of the certifying doctor. Concerns regarding the utility of the death certificate in the UK, prompted in part by the investigation into the homicidal activities of an English doctor, Harold Shipman, which came to light in the late 1990s, have led to proposals for legislative reform in England and Wales. It is anticipated that all death certificates will be scrutinized by a 'medical examiner' who will form a new link between the local health authority and Coroner, identifying cases for further investigation and trends in the local population. International classifications of disease are now well established and the WHO produced a book, 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, which simplifies both data recording and data analysis and allows information from many national and international sources to be compared.

In some countries, doctors also have to record the manner of death (e.g. homicide, suicide) on the death certificate, as advocated by the WHO; however, in most Western countries with an efficient medico-legal investigative system, the conclusion about the manner of death is delegated to a legal officer, for example the Coroner in England and Wales, the Procurator Fiscal in Scotland or the Medical Examiner in some of the states of the USA (Figure 3.1)

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, whether by burial or cremation. 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. In England and Wales there are approximately 500 000 deaths each year, of which over half are certified by doctors without referral to Coroners. In 2009, just under 230 000 deaths were reported to Coroners, of which approximately 106 000 required a post-mortem examination to determine the cause of death.

The types of deaths that cannot be certified by a doctor are examined by a variety of legal officers in other countries: Coroners, procurators fiscal, medical examiners, magistrates, judges and even police officers. The exact systems of referral, responsibility and investigation differ widely, but the general framework is much the same. 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 (Figure 3.2).

Figure 3.2 Examination of skeletal remains at a wooded 'scene'. The forensic pathologist wears appropriate protective equipment in order to prevent contamination of the remains. The attendance at a 'scene' follows discussion with the crime scene manager regarding the health and safety implications of the 'scene', the approach to the body/remains and a forensic strategy for the recovery of 'trace evidence', including swabs and 'tape lifts' from sites such as exposed skin surfaces and body orifices.



There is currently no common-law duty for a doctor to report an unnatural death to the Coroner, but legislative changes are imminent in England and Wales, and will place a statutory duty on all doctors to

report certain categories of death to the Coroner. The Registrar of Deaths already has such 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.

Following the death of a person who has not been receiving medical supervision, and where no doctor was in attendance, the fact of death can be confirmed by nurses, paramedics and other healthcare professionals as well as by doctors. The police will usually investigate the scene and the circumstances of the death and report their findings to the Coroner or other legal authority. The Coroner, through his officers, will attempt to find a family practitioner to obtain medical details. That family practitioner, if found, may be able to complete the death certificate if he is aware of sufficient 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 usually exercise his or her right to require an autopsy, but in Scotland the ability to perform only an external examination of the body on cases such as this – the so-called ‘view and grant’ – is well established.

This all-embracing coronial power to order autopsies is not found in other countries, where autopsies are often much more restricted. It is not surprising, therefore, that the autopsy rate varies widely from jurisdiction to jurisdiction; in some cases it is nearly 100 per cent but it may fall as low as 5–10 per cent. Some jurisdictions with low autopsy rates insist on the external examination of the body by a doctor with medico-legal training. Autopsy examinations are not the complete and 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. At least one-third of the causes of death given by doctors have been shown to be incorrect by a subsequent autopsy.

In England and Wales, Coroners’ jurisdiction begins when they are informed that a body of a person is lying within their district, and there is reasonable cause to suspect that the deceased died a violent or unnatural death, has died a sudden death of unknown cause, or has died in custody or prison (Coroners Act 1988, Section 8).

Deaths are usually referred to the Coroner by doctors, police and members of the public. The circumstances in which the Registrar of Deaths currently must refer a death to the Coroner are contained in the Registration of Births and Deaths Regulations 1987:

- the deceased was not attended in his last illness by the doctor completing the certificate;
- the deceased had not been seen by a doctor either after death or within 14 days prior to death;
- Where the cause of death is unknown;
- where death appears to be due to poisoning or to industrial disease;
- where death may have been unnatural or where it may have been caused by violence or neglect or abortion or where it is associated with suspicious circumstances;
- Where death occurred during a surgical operation

or before recovery from an anaesthetic.

Once a death is reported, the Coroner, if satisfied that it is from natural causes, can decide not to pursue any further enquiries and to ask the doctor to issue a death certificate. Alternatively, and more commonly, he may order an autopsy and, if this reveals that death was from natural causes, may issue a certificate to allow for disposal of the body. If the autopsy cannot establish that death was from natural causes, or if there is a public interest in the death, the Coroner may hold an inquest (a public inquiry into the death). The modern inquest is severely restricted in its functions and the verdicts it may return. An inquest seeks to answer four questions: who the person is, when and where they died and how they died (Coroners Rules 1984). The 'who', 'when' and 'where' questions seldom pose a problem; it is the answer to the fourth question – the 'how' – that is often the most difficult.

The Coroner can sit with or without a jury, except in some specific cases (e.g. deaths on a rail-track or in a prison) when they must sit with a jury. The Coroner's court cannot form any view about either criminal or civil blame for the death.

A Coroner or the jury has a prescribed list of possible verdicts and, although riders or comments may be attached to these verdicts, they must not indicate or imply blame. The commonly used verdicts include:

- unlawful killing (which includes murder, manslaughter, infanticide, death by dangerous driving);
- lawful killing (legal use of lethal force by a police officer);
- accident (misadventure);
- killed himself/herself (suicide);
- natural causes;
- industrial disease;
- abuse of drugs (dependent or non-dependent);
- open verdict (where the evidence is insufficient to reach any other verdict).

There is an increasing trend, however, for the Coroner to deliver a 'narrative verdict' which is a factual record of how, and in what circumstances, the death occurred, and this is often used in those cases in which the cause of death does not fit easily into any of the 'short-form' verdicts. Within the narrative verdict the Coroner may request an inquest jury (if the inquest is held before a jury) to address specific questions perceived to be of concern.

The autopsy

The words autopsy, necropsy and post-mortem examination are synonymous, although postmortem examination can have a broader meaning encompassing any examination made after death, including a

simple external examination. In general terms, autopsies can be performed for two reasons: clinical interest and medico-legal purposes.

The clinical autopsy is performed in a hospital mortuary after consent for the examination has been sought from, and granted by, the relatives of the deceased. The doctors treating the patient should know why their patient has died and be able to complete a death certificate even in the absence of an autopsy. These examinations have been used in the past for the teaching of medical students and others, and for research, but have been in decline worldwide for several decades.

The medico-legal autopsy is performed on behalf of the state. The aims of these examinations are much broader than those of the clinical autopsy; they aim to:

- identify the body;
- estimate the time of death;
- identify and document the nature and number of injuries;
- interpret the significance and effect of the injuries;
- identify the presence of any natural disease;
- interpret the significance and effect of the natural disease present;
- identify the presence of poisons; and
- interpret the effect of any medical or surgical treatment.

Autopsies can, in theory, be performed by any doctor, but ideally they should be performed by a properly trained pathologist. Medico-legal autopsies are a specialized version of the standard autopsy and should be performed by pathologists who have had the necessary training and experience in forensic pathology. The autopsy should be performed in a mortuary with adequate facilities (Figure 3.3). Guidelines for an autopsy are contained in Appendix 1 (p.240).

However, where there is no trained staff or no adequate facilities – which can occur not only in some developing countries but also in some so-called developed countries that do not adequately fund their medico-legal systems – non-specialist doctors may occasionally have to perform autopsies and histopathologists may have to perform medicolegal autopsies. A poorly performed autopsy may be

considerably worse than no autopsy at all; it is certainly worse than an autopsy delayed for a short while to await the arrival of a specialist.

The first crucial part of any autopsy is observation and documentation and these skills should lie within the competence of almost every doctor. All documentation should be in writing, and diagrams, drawings and annotations must be signed and dated at the end of the examination. Photographs are extremely useful in all medico-legal autopsies, but are essential in suspicious deaths. Photographic documentation of injuries should include a scale and some anatomical reference point for ease of review.

Figure 3.3 Modern forensic autopsy facilities, including directional overhead lighting – with inbuilt video projection and recording capability – to facilitate optimal forensic pathological examinations



Many autopsies will require ancillary investigations, such as radiological, toxicological, biochemical and microscopic analyses. (Figure 3.4, Figure 3.5) These will all have financial implications. Such matters and unwillingness of some individuals to allow autopsy on relatives have been active drivers in exploring other means of undertaking appropriate examinations to establish cause of death.



Figure 3.4 Operating microscopy in the forensic autopsy suite facilitates detailed examination and documentation of pathological findings.



Figure 3.5 Post-mortem radiology is important in many cases in forensic pathology. Note the body is enclosed in a body bag to prevent contamination of the body and loss of 'trace evidence' from the surface of the body, prior to autopsy. Hands (and usually feet) are similarly protected by paper or plastic bags before recovery of a body from a scene.

There is substantial interest in many countries into the utility of more modern radiological modalities, such as computed tomography (CT) and MRI, in a post-mortem setting, and results of studies suggest that there is potential for virtual autopsy ('virtopsy') techniques playing a significant role, where such facilities are available, in reducing the requirement for a full autopsy examination.

The use of imaging techniques in forensic medicine also has potential for wider application in the clinical setting for survivors of, for example, manual strangulation or stabbing, where injury characteristics can be better defined.