MEDICAL DEFINITIONS OF DEATH

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Introduction

Recent medical technological developments have led to a need to extend the definitions of death to cover unusual and unnatural situations where the traditional criteria of death cannot easily be applied. In particular the concept of brain death has had implications for both medical and legal practice, which have given rise to considerable controversy in several countries. Although this account is written from the UK perspective, reference is also made to problems elsewhere.

History of Definitions of Death

This title might seem to imply that recognizing death, as well as recording its cause, has long been a medical matter. For centuries, information about deaths depended on entries in parish registers by clergymen, who relied on what families told them. These were the basis of the Bills of Mortality that feature in historical accounts of death rates in communities and of the frequency of different fatal diseases. The Registration Act of 1836 (for England and Wales, but not applied to Scotland until 20 years later) led to more formal recording of deaths. Books of death certificates were sent out to 10 000 medical practitioners in 1841 but how these recipients were selected is uncertain because there was no medical register to identify *bona fide* doctors until 1858. In 1874 an official recommendation requiring a medical certificate for registering a death was introduced. However, the doctor could certify the death without having seen the patient in the preceding 2 weeks or without verification of death by inspection and this holds good even now. Poor people or those who lived in remote areas often did not have a doctor and this led to registration of uncertified deaths in some places. Because of this a parliamentary investigation was initiated in 1893, in which one report indicated that 40% of registered deaths were uncertified in Inverness, compared with only 2% in Glasgow.

Since biblical times the conventional sign of death was the absence of respiration, as verified by no movement in a feather or no misting of a mirror held in front of the nostrils and mouth. The unreliability of this as a sign of death was widely recognized in the eighteenth century when fear of premature burial led to various types of ingenious devices to enable victims of a mistaken diagnosis of death to signal to the living that they were still alive. In 1740 a paper entitled "The uncertainty of the signs of death and the danger of precipitate internments" concluded that putrefaction was the only sure sign of death. Signs sooner than this that would have been available at that time include rigor mortis and the coldness of the body (given that the ambient temperature was reasonable).

The introduction of the stethoscope in the nineteenth century led to attention being focused on the heartbeat rather than respiration as a more reliable sign of life. Recently a professor of forensic pathology made recommendations on confirming recent death. These include listening to the chest with a stethoscope for 2 min, detecting lack of tension in the eyeballs, observing that the pupils are in midposition with no reaction to light, and viewing with an ophthalmoscope the segmentation of blood in the retinal veins, which occurs very soon after death (an appearance known as "railroading" or "cattle-trucking"). By no means all of these procedures (or indeed any of them) are routinely carried out in practice and occasional mistaken declarations of death do still occur, sometimes only recognized after removal to the mortuary. Circumstances that may lead to simulation of death, when special care should be taken to avoid such a mistake, include drug overdose, hypothermia, electrocution, and drowning. If an electrocardiogram is available in such a situation the presence of continuing heart action can be reliably detected or excluded and this may help in correct declaration.

Consequences of Recent Technologies

If the introduction of the stethoscope made the definition and recognition of death easier, the development in the early 1950s of certain resuscitation and life support technologies has confused the issue and has led to the need to redefine death under certain artificial conditions. For example, cardiac defibrillators are now widely available not only in hospitals but also in ambulances and other locations that deal with emergencies in public places. These may enable a heart that has stopped to be restarted – and if the intervention is timely the patient may recover

adequately. During cardiac surgery the heart may be deliberately stopped for an extended period during which the circulation of the blood is maintained by an external pump (cardiac bypass). In such cases it may not be correct to suggest, except in an attempt to dramatize the event, that these patients have recovered after having been dead. The development of small portable mechanical ventilators to substitute for failed breathing has posed more of a problem, necessitating the emergence of a new definition of death – brain death. This concept and its practical implications are now widely accepted in many countries, albeit after some controversy. Together with the development of organ and tissue transplantation these technologies have led to the recognition that death is a process rather than an event because not all organs and tissues become nonviable at the same time. The World Medical Association Declaration of Sydney in 1968 stated that, from a medical viewpoint, the time of death of different organs and cells is less important in determining the death of the individual than the certainty that the process has become irreversible. Others have stated that it is not the death of the whole organism that matters, but the death of the organism as a coordinated whole. At what point during the process of dying an individual is regarded as having died is to some extent arbitrary. At different stages in this process it may be appropriate to abandon futile treatment, to remove organs for transplantation, to move the body to the mortuary, or to dispose of the body.

The Concept of Brain Death

The process of dying is most commonly initiated by the arrest of either the heart (i.e., the circulation of the blood) or, less often, of the breathing. The consequence of either event is that within minutes the brain also fails irreversibly from lack of oxygen and there is death of the brain. However, even an hour later kidneys may be removed and will survive if transplanted, and many hours later corneas or bone may be retrieved and preserved for later transplantation. When breathing has ceased a mechanical ventilator can restore respiratory function. If respiratory failure is due to spinal injury or disease, prolonged survival with full mental function is possible by continuing with mechanical ventilation. If a ventilator is needed because of failure of the respiratory drive from the brainstem, then provided this was started sufficiently quickly so that further irreversible brain damage did not occur from lack of oxygen, full recovery is possible if the brainstem failure proves to be temporary. If, however, the brain failure proves to be irreversible (either from primary brain damage or as a result of delayed resuscitation), the ventilator may only serve to prolong the process of dying. It allows the heart to continue to beat and to maintain the blood circulation, which supports the function of other organs. This state of artificially maintained ventilation with the heart continuing to beat and the patient kept warm and pink, although the brain is dead, is termed brain death. This unnatural state is the price paid by these patients for the successful ventilation of other patients because, inevitably, those who initiate mechanical ventilation as an emergency resuscitation measure do not then know whether the brain can recover. After brain death it is usually only a matter of a few days before the heart stops, but during this time the brain may begin to decompose. Exceptionally, bodily survival after brain death may be extended for some weeks when special efforts are made in a pregnant woman to maintain the life of the fetus until it can survive delivery.

Controversies about Brain Death

These have centered on the motivation for recognizing this condition and on the reliability of criteria for its diagnosis. It was intensive care specialists who originally described brain death because they were anxious to avoid having to continue to ventilate comatose patients with irrecoverable brain damage. To do so was considered to deprive the patient of death with dignity, to prolong needlessly the distress of relatives, and to be an inappropriate use of scarce resources. However, organ transplantation emerged at about the same time as the concept of brain death and this led some to assert that brain death had been identified primarily in order to facilitate the provision of donor organs. In fact it was not until 10 years after brain death had been described that there was more than one kidney transplant per week in the UK. At that time most kidney donors were cadavers from whom organs were removed some time after the heart had stopped, while other kidneys came from healthy volunteers. Indeed, in an American review in 1971 more than half the transplants were from living donors. What the definition of brain death did for kidney transplantation was to remove from cadaver donation the sense of unseemly haste to remove organs once the heart had stopped, because there was now a window of several hours for discussion with relatives before kidneys had to be removed. By 1977 one British transplant unit reported that two-thirds of its kidneys came from brain-dead donors but

4 years later all came from such a source. Even so, a few units still use some donors declared dead only after the heart has stopped, whilst increasing numbers of kidneys now come from volunteer living donors. By contrast, the more recent development of heart and lung transplantation depends entirely on brain-dead donors because the heart has to be still beating when it is removed. But heart transplantation only became a frequent procedure after 1979, 20 years after the first description of brain death. In practice only a fraction of brain-dead patients become donors because some are unsuitable for medical reasons whilst for others permission is either unable to be sought or is withheld by relatives. If transplantation were ever to be superseded by alternative treatments there would still be several thousand brain-dead patients in intensive care units every year for whom a decision about whether to continue ventilation would have to be made.

Table 1 Preconditions before testing for brain death

- Deep coma persisting after correction of systemic hypotension and hypoxia, and attempts to reduce high intracranial pressure
- Apnea requiring continuous mechanical ventilation
- Evidence of severe structural damage to the brain, e.g., head injury, intracranial hemorrhage, or an episode of severe systemic hypotension or hypoxia
- Exclusion of causes of temporary brainstem failure, e.g., depressant drugs, muscle relaxants, hypothermia

Table 2 Tests for brain death (after preconditions have been satisfied)

- Absent corneal, papillary, and gag reflexes
- No eye movements in response to ice-cold caloric stimulation (oculovestibular reflex)
- No respiratory movements when $Paco_2 > 6.65$ kPa during ventilator disconnection while oxygen is delivered at 6 l min^{-1} via endotracheal tube (apnea test)

The Diagnosis of Brain Death

Criteria for the diagnosis of brain death were first formally published in 1968, 10 years after the phenomenon was first described. The Harvard committee that developed these criteria included lawyers and theologians as well as anesthetists, neurosurgeons, and neurologists. The Harvard criteria required that there be absence of all motor activity and that the electroencephalogram (EEG) be flat – that is, showing no electrical activity in the brain. This implied the necessity for evidence that the whole of the central nervous system was no longer functioning – the cerebral cortex, the brainstem, and the spinal cord. It was subsequently observed that limb movements from spinal cord reflexes can persist after brain death, because the cord is less vulnerable than the brain to hypoxic insult. Although the brainstem is necessary for coordinated activity in the higher brain as well as for spontaneous breathing it has become apparent that residual physicochemical activity with some electrical component can persist in some isolated cortical areas above a dead brainstem in some patients. As a result, the emphasis is now on the death of the brainstem rather than of the whole brain and this is a feature of the UK criteria. These were developed by a Health Department committee that included a coroner, a barrister, and a patient representative, and were subsequently agreed and published in 1976 by the UK Medical Royal Colleges. They require that certain preconditions should be met before embarking on tests to confirm brain death (Table 1). These are that the patient is in deep coma and has been on a ventilator since the arrest of spontaneous breathing (apnea), that the diagnosis of irreversible brain damage has been established, and that there are no confounding factors that could cause temporary depression of activity in the brainstem (such as depressant drugs or hypothermia). If these preconditions have been met the diagnosis can be made on the basis of simple bedside tests to exclude continuing function in the brainstem (Table 2). These must always include the important apnea test to establish without doubt that there is still absence of spontaneous breathing.

The UK criteria require that the tests be carried out on two occasions (without any specified time interval between the two tests) and that two experienced doctors should be involved. A further memorandum from the UK Colleges in 1979 asserted that if the brainstem is dead then the brain is dead and if this is so then the patient is dead. According to this it is therefore appropriate to declare death when the brain death tests are satisfied for the second time, and this should be recorded as the time of death for legal purposes. The subsequent withdrawal of the ventilator is then regarded as the removal of an inappropriate technological procedure from a person who is already dead, rather than an intervention to allow that patient to die. When two convicted prisoners claimed on appeal that their victims had died as a result of doctors withdrawing the ventilator after brain death, the Lord Chief Justice opined that it would be otiose to suggest that when medical treatment had failed to save the life of a patient the doctors who withdrew

that treatment should be considered responsible for that person's death.

That legal case occurred in the aftermath of a challenge to the validity of the UK criteria in a notorious BBC Panorama program in 1980 entitled "Transplants – are the donors really dead?" This asserted that brain death was a concept that had emerged from the medical profession without proper discussion – in spite of the fact that it had been ratified on both sides of the Atlantic by committees that included nonmedical members. It also alleged that its emergence was primarily to satisfy the need for organ donors, although as already explained, that was not the case. But its most serious allegation was that the UK criteria were less reliable than those in other countries because there were no mandatory confirmatory tests, in particular the EEG. Doctors from the USA and France supported these allegations and there were interviews with patients who had been mistakenly declared to be brain-dead in the USA. After an unprecedented period of controversial discussion in the newspapers, medical journals, and in the House of Commons, the BBC exceptionally allowed a team of British doctors to make a reply program that answered the criticisms, with the on-screen support of other doctors from the USA. This program established that none of the patients alleged in the original program to have recovered from supposed brain death would have been declared to be brain-dead by the UK criteria. There has subsequently been no modification of the UK criteria, apart from a preference for the term "brainstem death." Indeed, many other countries as well as many institutions in the USA have subsequently adopted criteria for the diagnosis of brain death that are virtually identical to those published in the UK.

Brain Death Legislation

The UK has not considered it necessary to bring in legislation to deal with brain death: a patient is dead when a doctor declares this, and on what basis that was done is regarded as a medical matter. However, as early as 1970 the US state of Kansas enacted a brain death law and many other American states have since followed suit, as have several European countries. These laws stipulate that death may be declared by neurological criteria but do not specify these criteria, indicating instead that these should be according to the standards of the day – recognizing that these may change. The reason why laws are deemed necessary in some places is in order to protect doctors and to anticipate and thereby avoid futile appeals by convicted assailants that they were not responsible for the subsequent deaths of their victims.

In many countries the concept of brain death and its practical implications are accepted without continuing controversy. However, in three countries active debate did continue long after the issue seemed to have been settled elsewhere. In Denmark in 1985 a transplantation committee recommended accepting brain death criteria but when the Ministry of Justice proposed a bill 2 years later there was strong opposition in the media. A Council of Ethics in 1989 proposed that organs could be removed during the death process but that the time of death should be when the heart later stopped. Copies of this were widely distributed to the public, 200 local debating groups were set up and a video film was shown to more than 500 local groups. The law, passed in 1990, was virtually identical to that proposed in 1987 before the public debate. In Germany, acceptance of brain death went unchallenged for over 20 years. However, draft legislation to formalize accepted practice in 1995 stirred up opposition coordinated by the Berliner Initiative Against Brain Death, but the proposed law was eventually passed in 1997.

In Japan the debate was much more contentious and prolonged. Over many years one pediatric neurologist organized steady opposition to brain death, maintaining that it was no more than an aid to transplantation. In 1988 the Japanese Medical Association voted to accept the concept, but divisions appeared between specialists, some of whom feared that the disabled might become unwilling donors. In 1992 a cabinet committee was deeply divided but the majority approved the acceptance of brain death, but this was rejected the next day by the Ministry of Justice and the police. Eventually a law was passed in 1997 accepting brain death but this was restricted to patients for whom permission had been given for transplantation. This thereby emphasized the connection between brain death and transplantation that other countries had striven so hard to play down.

The Present Situation

In 1999 an American book, *The Definition of Death,* suggested that there were unresolved controversies in the USA about brain death that some academics believed should be debated. In particular, the assertion that brain-dead patients were already dead was believed by some to be incoherent. It stemmed from the dead donor rule – the insistence of transplant surgeons that potential donors and their families

should be told that their organs would be taken only after the death of the donor. It now seems to some that it would be more realistic to admit that there is a stage in the irreversible process of dying when it is appropriate to take organs without having to declare the patient already dead. This makes it no different from acknowledging that at an earlier stage in this dying process it may be appropriate to withdraw all active treatment. There is, however, no evidence that there is pressure in the public domain to enact such a change, particularly not in the UK where the long-standing diagnostic criteria and the present legal position have served so well.

An ethical dilemma does sometimes arise when relatives are unwilling to accept the diagnosis of brain death and object to the discontinuation of ventilation. Such denial may arise from confusion in the minds of relatives between the formal diagnosis of brain death and other states such as the persistent vegetative state and deep coma from which they have heard that patients declared irrecoverable do sometimes recover. They need to have it explained that these are quite different conditions and that the diagnosis of brain death with its formal protocol and involvement of two doctors is more reliable than any other medical diagnosis and implicit in that diagnosis is that the patient cannot recover. In such circumstances it is very helpful to be able to point out that legally the patient is already dead, and that legally it is only the doctor who can decide about the appropriateness of continued treatment. In such circumstances permission is no more needed to stop the ventilator than it is needed to move the body to the mortuary.

See Also

Coma, Definitions and Differential Diagnoses: Pediatric; Adult; **Head Trauma:** Neuropathology; **Legal Definitions of Death**; **Organ and Tissue Transplantation, Ethical and Practical Issues**; **Religious Attitudes to Death**

Further Reading

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