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Linacre Institute Position Paper

Determination of Death

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During most of modern history, there was a close correlation between the popular concept of death and the medical determination of death. In each circumstance, death was construed as the absence of so-called "vital signs" of heartbeat and respiration. There was, from the beginning, anxiety about the reliability of criteria used by physicians to declare death.¹ Morbid preoccupation with the risk of premature burial persisted through the 18th and 19th centuries because of the limitations of the existent technology for discerning the absence of vital signs.² Macabre stories of corpses reviving and exhumed coffins showing signs of attempted escape led to elaborate escape mechanisms being incorporated into caskets (Figure 1). The development of the stethoscope in the 19th century greatly enhanced the reliability of auscultation and the development of the electrocardiogram in the 20th century was a milestone in sophisticated technology for confirming the absence of heartbeat.

Later in the 20th century, however, the development of other technologies actually compounded the inability of physicians to determine death reliably. The physician was able to support respiration artificially with several generations of improved ventilators and when cardiac pacemakers made it possible to support the heartbeat artificially, the traditional reliance on "vital signs" became dubious. It was at this point that the interrelationship of cardiac, respiratory, and central nervous system functions became the focus of modern explorations of the means to determine death.

Basic Physiology

The control of respiration is centered in the brain stem. Neural impulses originating in the respiratory centers in the medulla stimulate the primary nucleus of respiration. The rate and depth of respiration are adjusted to the control of levels of oxygen and carbon dioxide in the system. Destruction of the brain's respiratory centers leads to the stoppage of respiration which

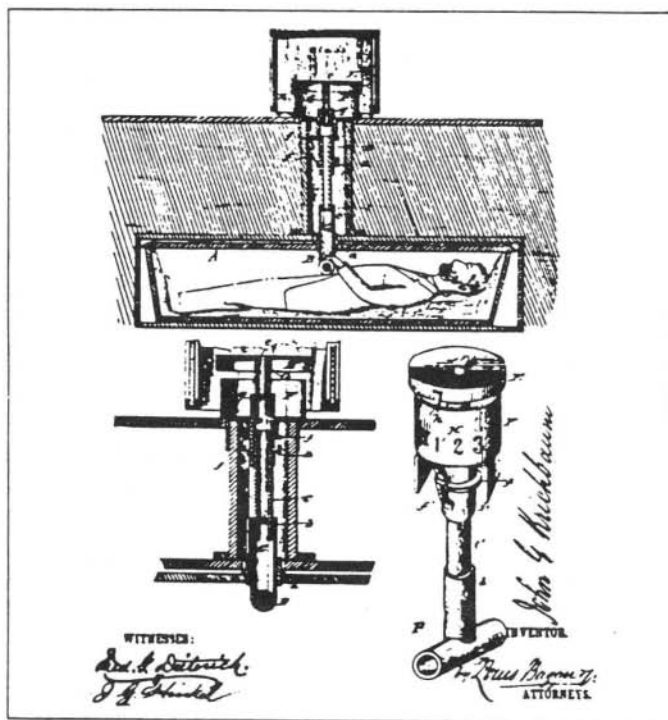


Figure 1. Kirchbaum's device for indicating life in buried persons, Patent sketch, 1882.

in turn deprives the heart of required oxygenation causing it also to cease functioning. The traditional vital signs of respiration and heartbeat disappear leading to a declaration of death. The interdependent functions of respiration, circulation and the brain are thus demonstrated in the diagnosis of death.

The use of artificial life support mechanisms, however, complicates this interdependence. The artificial respirator can compensate for impaired neuroregulatory control of respiration by regulating the rate and depth of respiration and thereby regulating blood gas levels in the circulation.

Whereas the respiratory system depends on impulses from the medullary control system, the heart can pump blood without external control. Brain centers modulate heart rate, but are not essential for the heart to contract at an adequate level of function. When adequate oxygenation is maintained by artificial respiration, an intact heart will continue to beat independent of the control of the central nervous system, at least for a limited time.

The availability of artificial life support has thus given rise to the need for brain-based methods for the determination of death. The irreversible loss of total brain function has been proposed as tantamount to death in the patient whose cardiac and/or respiratory functions are being artificially supported.

Brain Death Controversy

The issue of determination of death by brain-based criteria must be clearly delineated from other controversies.

- 1) *The persistent vegetative state.* When brain stem function remains but the major components of cerebral function are irreversibly destroyed, the patient is not "brain dead". Such patients may exhibit sleep-wake cycles, yawning, involuntary movements, and independent respiration.³ Controversies regarding food and drink for those in persistent vegetative states are not relevant to those who have suffered whole brain death.
- 2) *"Do not resuscitate" orders.* This is fundamentally a decision that cardiopulmonary resuscitation and other extraordinary measures are contraindicated because of the hopelessness of the patient's prognosis. A declaration of death is not required before ceasing treatment.
- 3) *Anencephalic organ donation.* The anencephalic infant is born with brain stem function and is therefore not qualified as an organ donor.⁴ It is precisely because the anencephalic is not demonstrating whole brain loss of function that it would be immoral to use him as an organ donor.
- 4) *Ordinary versus extraordinary care.* The formulation of Pius XII regarding the physician's and the patient's differing obligations to use or accept certain forms of therapy is not relevant to the patient who has been declared dead. Such a patient is beyond benefit or burden. Brain-based determinations of death are most commonly employed in the patient on extraordinary forms of artificial life support.

Concept and Consensus

In clinical practice, irreversible loss of function of the whole brain most commonly results from 1) direct trauma of the head such as from motor vehicle accident or gunshot wound; 2) massive spontaneous hemorrhage into the brain as a result of ruptured aneurysm or complications of hypertension, or 3) anoxic damage from cardiac or respiratory arrest or severe hypertension. Severe injuries of this type in a closed cavity like the skull result in cerebral edema sufficient to cause increased cerebral pressure in excess of systolic blood pressure. When this happens, blood flow to the whole brain will be interrupted and the neurons deprived of oxygen and glucose. A loss of blood flow for about five minutes will typically damage the cerebral cortex permanently and a 15 minute loss will permanently destroy the more resistant brain stem. Persistent loss of circulation will cause brain tissue to autolyze over ensuing days.

When the brain has lost all functions, consciousness is lost along with cognitive and affective functions as well as the integrating functions of the

brain stem. The intensive care unit in such instances may "substitute for the brain stem". The brain stem is the locus of homeostatic control, cranial nerve reflexes and control of respiration. Through its reticular activating formation, it is essential to generating consciousness.⁶ Respiration and circulation can be generated by the use of ventilators in an intensive medical care environment, but this mechanically produced function will not continue indefinitely. Cardiac function usually fails in a matter of days in adults although it may sometimes be sustained for a period of weeks in infants and children.⁷

In recent years, several procedures have been developed to test for absence of intracranial blood flow including radioisotope cerebral angiography and four vessel intracranial contrast angiography.⁸ These tests can be carried out at the bedside and are highly reliable. In addition, bedside clinical evaluation for brain stem function is carried out. The patient is tested for 1) fixed pupils; 2) absence of corneal reflexes; 3) absence of doll's eyes reflexes; 4) unresponsiveness to caloric testing for vestibular function, and 5) apnea testing. This last test is performed by removing the patient from the ventilator and placing him in a 100% oxygen environment. Blood gases are measured every five minutes until the PCO₂ is above 60 mmHg. Failure to reestablish respiration indicates a non-functional respiratory center. The state of the art of intensive care medicine currently provides for the accurate and reliable assessment of total brain function (see Appendix I for a suggested protocol).

The brain stem is responsible for the neurological integration of various organ systems. Brain-based criteria define death as the point at which the body's physiological system ceases to function as an integrated whole. This view holds that continued breathing and circulation are not tantamount to life since they can be maintained, at least temporarily, by artificial life support. Given the advances in cardiopulmonary support, how can the evidence for death be obtained? When the use of mechanical ventilation precludes reliance on traditional vital signs of heartbeat and respiration to ascertain whether a person is alive, the use of brain-based criteria provides another means of making such a determination.⁹ The use of brain-based criteria does not introduce a "new kind of death", but rather reinforces the concept of death as the phenomenon in which there is disintegration of the organism as an integrated whole. Although, historically, absence of heartbeat and respiration have been described as means for "defining death", it is clear both from history and current medical understanding that these observations were really evidences for the disintegration of the organism as a whole. Brain-based criteria are always to recognize that this phenomenon has occurred in an era of sophisticated measures for artificial life support.

Critique of Brain-Based Criteria

The most serious allegation made against brain-based criteria is that they are part of a hidden agenda to qualify donors for transplantation,

particularly of unpaired organs. While there is no doubt that the development of brain-based criteria occurred contemporaneously with scientific advances in organ transplantation, their use in practice is only minimally related to organ donation.¹⁰

The Presidential Commission reported that six of 36 patients declared dead on the basis of irreversible loss of total brain function in their small study in a tertiary care center were organ donors. Even this figure is much too high for centers where transplantation surgery is not carried out on the premises. In a survey of hospitals in the Chicago area of 450 patients declared dead by brain-based criteria, three kidneys were donated. In the remaining 99.33% of cases, the criteria were employed for purposes of removing patients from futile artificial life supports.¹¹

The brain-based standards are merely supplementary to the existing cardiopulmonary standards which will continue to be adequate in the overwhelming majority of cases. In a survey of four acute care hospitals done by The Presidential Commission, 92% of patients were declared dead on the basis of cardiac arrest. Brain-based criteria are only relevant to a limited population of terminally ill patients, i.e., comatose patients on respirators. Even among the 8% who qualify as having irreversible cessation of total brain function, including the brain stem, some will develop a systole during the waiting period necessary, before the ventilator is discontinued. Other physicians will conclude that dying patients have no chance of recovery and will forego placing the patient on a respirator against the time when brain-based criteria supervene.

The need to monitor transplantation practices in a scrupulous manner is of the utmost importance, however. The physicians declaring a patient dead should certainly have no contact or affiliation with the transplant team and the ghoulish practice of transplant surgeons lurking around emergency rooms looking for fatal motorcycle accident victims, is to be totally condemned. There is no denying that patients have been prematurely declared dead more often by incompetence than by design. The unscrupulous physician who wishes to declare a patient dead for ulterior motives of any kind can as easily disregard cardiopulmonary as brain-based criteria. The non-paying elderly patient in a critical care bed during a bed crisis is much more at risk than the young potential organ donor whose demise will be subject to universal scrutiny by vigilant staff.

As Shewmon argues convincingly: "The truth or falsity of a proposition is not determined by its abuse potential. Doctors and neurologists in particular are in general quite scrupulous about applying brain death criteria. When errors have been made they have usually been in the direction of an irrational reluctance to declare brain death in spite of the standard clinical criteria having been met."²³

Basis for Criticism

Another basis for criticism of current brain-based standards is to point out the lack of scientific underpinnings for earlier promulgated criteria.

These are not superseded by the standard developed by The Presidential Commission which is as follows:

"An individual who has sustained either 1) irreversible cessation of circulatory and respiratory functions, or 2) irreversible cessation of all functions of the entire brain, is dead. A determination of death will be made in accordance with accepted medical standards." The last sentence is important inasmuch as medical standards will change as the technology for recognizing irreversible loss of function develops.

A landmark in the process of developing criteria which reliably establish permanent loss of brain functions was the 1968 publication of what have become known as the "Harvard Criteria". This was a report of an *Ad Hoc* Committee of the Harvard Medical School. Since it was, in effect, a consensus conference, it did not cite supporting clinical research for its report. The Committee report described the following characteristics of a permanently non-functioning brain, a condition it called "irreversible coma".¹²

1) Unreceptivity and unresponsivity. The patient is totally unaware of externally applied stimuli even if intensely painful.

2) No movements or breathing: Spontaneous muscular movement, spontaneous breathing, and response to touch, sound and light are absent.

3) No reflexes, fixed dilated pupils, lack of doll's eyes reflex, non-responsiveness to caloric stimulation, absent tendon reflexes.

In addition, a flat electroencephalogram was recommended as a confirmatory text. All tests were to be repeated 24 hours later without showing change. Drug intoxication (such as barbiturate poisoning and hypothermia which can cause a reversible loss of brain function) had to be excluded before the criteria were used. Criticism of these criteria have been as follows: 1) the phrase "irreversible coma" is misleading since coma is a condition of a living person; 2) spinal cord reflexes can persist even after the brain ceases to function; 3) "unreceptivity" cannot be tested in an unconscious patient; 4) the need to test brain stem reflexes, especially apnea, and to exclude drug and metabolic intoxication is not made explicit and precise; 5) many individuals who are dead do not maintain a circulation long enough to have a 24-hour observation period.

Despite these criticisms, the Harvard Criteria have an enviable record of accuracy when properly employed.

Other Sets of Criteria

Numerous other sets of criteria have been proposed since 1968. The accuracy of various criteria depends on several factors: 1) the diagnosis of the cause of cessation of functions must be accurate and sufficient to explain the patient's clinical condition;¹³ 2) the criteria must be incompatible with sustained cardiac function even with intensive care support;¹⁴ 3) the demonstration of widespread necrosis of the brain in those on mechanical support long enough to sustain "respirator brain."¹⁵

The crucial factor in any set of criteria is an emphasis on loss of *total* brain function of the brain stem. If confirmed by the appropriate cerebral blood flow testing, loss of blood supply establishes irreversibility and destruction of the brain tissue. Sustained loss of brain stem function is not compatible with survival. As Pallis has pointed out,¹⁶ brain stem areflexia is highly significant prognostically even in the presence of some residual electroencephalographic activity (Fig. II).

There have been some objections to the equating of cessation of total brain function with total destruction of the brain.¹⁷ A brain with no circulation is either destroyed or in the immediate process of destruction, however. In measuring functions, physicians are not concerned with mere activity in cells or groups of cells if such activity is not manifested in a way that has significance for the organism as a whole. Cells of the heart or lungs may continue to have metabolic or electrical activity after death has been declared by cardiopulmonary standards.¹⁸ Byrne's standard for declaration of death is as follows: "No one shall be declared dead unless and until there is destruction of at least the three basic unifying systems of the body, namely the brain, the cardiovascular and the respiratory systems".¹⁹ It is clear that since destruction is not measured directly (e.g., by brain biopsy), it will have to be evaluated at the bedside by the disappearance of certain functions. Even rigor mortis, as a late sign that death has occurred, is a state of altered function related to the depletion of adenosine triphosphate in deteriorating muscles.²⁰

The most important inference to be drawn from an insistence on the destruction of all three structures of brain, cardiovascular and respiratory systems is that human cadaver transplantation would not be medically possible or ethically acceptable. Transplantation of unpaired organs such as the heart or liver (and probably the removal of both kidneys) would not be morally acceptable unless all three systems were destroyed. In the present state of technology, organs would not be suitable for transplantation under such circumstances. If brain-based criteria for the determination of death are not accepted, perfusion of organs by post-mortem artificial support of circulation is not acceptable.

Figure 2 **Prognostic significance of brain stem signs**
(*Structural brain lesions. No drug induced cases*)

<u>No. of cases</u>	<u>Brain stem areflexia</u>	<u>Apnoea</u>	<u>EEG</u>	<u>Asystole within days</u>
1000	All	All	"Isoelectric"	All
147	All	All	Some residual activity	All
16	None	None	"Isoelectric"	None

Human Heart Transplantation

The theological principles governing transplantation of the human heart have been well summarized by Lynch.²⁰

- 1) Such transplantations must be a necessary measure of last resort.
- 2) Transplantation must offer reasonable hope of substantial benefit to the recipient.
- 3) The procedure must be carried out by an operating team medically and surgically competent to carry it out.
- 4) Informed consent must be obtained both from the recipient and the donor (or next of kin authorized under the Uniform Anatomical Gifts Act).
- 5) The heart is not to be removed until there is moral certitude that medical death has occurred.

Father Lynch defines death in this context as cessation of vital functions beyond reasonable hope of resuscitation but defers, as a theologian, to the medical profession to set the standards for the determination of death. Pope Pius XII²¹ and Pope John Paul II²² have also emphasized the primacy of the physician's role in determining death.

Philosophical and Theological Considerations

The usual formulation of death is one not necessarily related to physiological phenomena. The view is traditional in many faiths that death occurs at the moment the soul leaves the body.²³ Since this is obviously not a medically observable phenomenon, an attempt must be made to find a consensus as to what constitutes such a state. Since we cannot know precisely when the spiritual soul leaves the body, it has been traditional for priests conditionally to anoint the patient as long as an hour after death has been declared.

The physician is obligated to safeguard life but he is not obligated to prolong the process of dying. There is a fundamental ambivalence for the physician involved in the care of terminally ill. He must guard against any inclination to declare death prematurely out of cost-benefit considerations or the desire to achieve benefits for next of kin or society at large. At the same time, he must guard against a futile vitalism which will result in the employment of extraordinary measures not in the best interests of the dying patient himself.

Shewmon, in a comprehensive and scholarly paper²⁴ associates the death of the person with the loss of neocortical function. He is of the opinion that the human essence is lost with the destruction of the "tertiary association cortices" which are "necessary for the proper functioning of the intellect and will". Moraczewski²⁵ is more inclined to identify the brain stem, as the integrating center of the brain, and as such, the instrument of the soul. The question is whether brain death is equivalent to the death of a person. Body and soul are two principles united to form one being. Embodied matter vivified by a soul is a person. The organ of integration is the brain and the integrating center of the brain can be considered as the conjoined

instrument of the soul which vivifies the body. This has been summarized by Grisez as follows: "Considering the role of the brain in the maintenance of the dynamic equilibrium of any system which includes a brain, there is a compelling reason for defining death in factual terms as that state of affairs in which there is complete and irreversible loss of the functioning of the entire brain. To accept this definition is not to make a choice based on one's evaluation of various human characteristics, but is to assent to a theory which fits the facts."²⁶

Definition of Death and the Pro-Life Movement

It must be conceded that there is an ethical pluralism on the definition of death among individuals and organizations involved in activism surrounding the issues of abortion, infanticide, and euthanasia. General agreement with brain-based standards for the determination of death has been expressed by spokespersons for the National Right to Life Committee,²⁷ American College of Pro-Life Obstetricians,²⁸ American Association of Pro-Life Pediatricians,²⁹ National Commission on Human Life,³⁰ and Americans United for Life.³¹ Comments on the matter in the literature support this view. The late Dennis Horan, former president of Americans United for Life Legal Defense Fund, stated,³² "Total brain death legislation enhances those values we seek to support by prohibiting euthanasia and allowing only those to be declared dead who are really dead." In a similar vein, Grisez³³ states, "A correct definition of death, if it would eliminate some false classifications of dead individuals as being among the living, could relieve some of the pressure for legalized euthanasia, pressure arising from a right attitude toward individuals really dead and only considered alive due to conceptual confusion." Such statements are not meant to convey anything more than the fact that many leading pro-life individuals and organizations involved in the euthanasia debate consider brain-based criteria to be not only acceptable but helpful to the pro-life cause.

Summary

The development of technical methods of supporting respirator with ventilators and maintaining heart action with pacemakers gave rise to the need for brain-based methods for the determination of death. The process of dying may in some instances, be reversed by resuscitation or other intervention. The physician has a moral obligation to safeguard and respect life but he is not obligated to prolong the process of dying. In some instances where resuscitation is possible, it will not be undertaken because the patient is in the terminal stages of an incurable illness. There comes a point where resuscitation will not be possible even if attempted. This is when there is irreversible cessation of total brain function including the brain stem. Such a state constitutes an injury which in the current state of medical knowledge is permanent and incurable. There is no record in the medical literature of

any single individual having recovered after having suffered such an injury, properly and objectively diagnosed. A patient who has lost the integration of vital processes through irreversible cessation of brain stem function would not be expected to be capable of maintenance of vital processes even if artificial support were to be provided. Death is the point at which the body's physiological system ceases to constitute an integrated whole. There may be a temporal difference between death of the organism as a whole and death of the whole organism. Some cells and tissues may continue to function after the irreversible loss of the integrated function of the organism as a whole. Death as the cessation of the function of the integrated whole brain is an end point and not an intermediate point. This is not to say that there will not be subsequent events which further confirm tissue destruction such as rigor mortis and putrefaction. In the absence of artificial life support, non-function of the brain stem will inevitably lead to cessation of heart beat and respiration. Continued breathing and circulation are not tantamount to life in the age of highly sophisticated artificial support.

Most people who die will be declared dead by cardiorespiratory criteria. The vast majority of persons declared dead by brain-based criteria will be on artificial life support and will not be organ donors for transplantation. The acceptance of brain-based criteria may be helpful in organized opposition to legalized euthanasia.

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Appendix I

A Model Algorithm for Determining Death by Neurological Criteria

Is the patient in deep coma (no eye opening, no spontaneous movement, and no response other than spinal cord reflexes to noxious stimuli) and on a respirator not showing respiratory effort? Does neurological exam confirm absence of brain stem reflexes including pupillary, corneal, oculocephalic (doll's eyes), oculovestibular (50 ml iced water irrigation into external auditory canal), corneal, gag, and cough reflexes?

No—If not possible to evaluate all reflexes, continue protocol, but at some point do cerebral blood flow study or EEG (helpful mostly if it shows activity) or consider consultation with someone with experience in the determination of death by neurological criteria.

Yes

Is patient over 5 years old?

No—If not experienced in the determination of death by neurological criteria in children, consider consultation with a specialist.

Yes

Is patient free of alcohol, barbiturates, other depressant drugs, neuromuscular blockade, uremia, or other severe metabolic abnormalities that may impair neurological function?

No—Wait until documented elimination of drug or correction of metabolic abnormalities or consider cerebral blood flow study or EEG (helpful mostly if it shows activity) or consider consultation.

Yes

Does patient have temperature above 90° F (32° C) and systolic blood pressure above 90 mm Hg?

No—Correct hypothermia and raise blood pressure or consider cerebral blood flow study or consultation.

Yes

Is patient free of conditions that might impair ventilatory threshold to hypercarbia and hypoxia (e.g., COPD, CHF)?

No—Do cerebral blood flow study or EEG or consider consultation.

Yes

Test for apnea (no spontaneous respirations with $pCO_2 > 60$ mm Hg).

No—If any respiratory effort, patient is not dead.

No—Inadequate test if arrhythmia or hypotension or other untoward effects before $pCO_2 > 60$. Do cerebral blood flow study or EEG or consider consultation.

Yes

Confirm that brain function is absent and irreversible by any one of the following:

1. At any time, four-vessel intracranial angiography. If no flow, patient is dead.
- or 2. During initial 6 hours after loss of brain function, radionuclide cerebral angiography. If no flow, confirm death by clinical examination, including apnea test, at 6 hours. (Radionuclide angiography can be used as a confirmatory test after this period as well.)
- or 3. At end of initial 6 hours after loss of brain stem function, EEG. If electrocerebral silence at least 6 hours after loss of neurological activity, confirm death by clinical examination, including apnea test.
- or 4. At the end of initial 12 hours after loss of brain function, if the cause of coma is clearly established and is other than hypoxia and if clinical examination including apnea test again shows no brain function, the patient is dead. Additional tests are not required.
- or 5. At the end of the initial 24 hours after loss of brain function, if the cause of coma is hypoxia/ischemia to the brain and if clinical examination including apnea test again shows no brain activity, and if the rest of the protocol has been satisfied, the patient is dead. Additional tests are not required.

Documentation: Complete documentation in the hospital record is essential and should include the date and time of the initial clinical evaluation including apnea test, the results of pertinent laboratory tests and confirmatory tests done, and the date and time of the final clinical evaluation including apnea test. This can be accomplished either by a written note or by using a form.

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