2021

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This article was originally published as:

O'Keeffe, F. J., & Mendz, G. L. (2021). Diagnosing death 50 years after the Harvard brain death report. *The New Bioethics*, 27 (1), 46-64.

Original article available here:

[10.1080/20502877.2020.1869469](https://doi.org/10.1080/20502877.2020.1869469)

This article is posted on ResearchOnline@ND at
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This is the accepted manuscript version of an article published as:

O’Keeffe and Mendz, G.L. (2021) Diagnosing death 50 years after the Harvard brain death report. *New Bioethics*, 27(1), 46-64. <https://doi.org/10.1080/20502877.2020.1869469>

This article has been published in final form at

<https://doi.org/10.1080/20502877.2020.1869469>

Diagnosing Death 50 Years after the Harvard Brain Death Report

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[Text of 7609 words]

Abstract

More than 50 years after the publication of the Harvard Committee Report that sought to define death according to whole-brain function criteria, this landmark document continues to generate a diversity of opinions regarding how death should be defined. The various viewpoints show that doubts linger regarding when brain death should be diagnosed, the criteria to pinpoint the occurrence of death, and the alignment of medical practices seeking to establish human death with these criteria. This paper reviews and assesses three perspectives that have made significant contributions to the debate. Attention is given to other definitions of death that depart from the recommendations of the Harvard Report. Appraisals of various arguments lead to the conclusion that changes in the definition of death have resulted from advances in knowledge of human biology, medical technology and diagnostic techniques. A commentary is included on expediting the time of death with the view of organ donation. Since criteria and indicative tests are required to establish the death of individuals, at any given moment rules based on the best available evidence need to be applied to declare death, whilst at the same time they should remain open to modification.

Key words: Harvard Report on brain death, whole-brain death, circulatory-respiratory death, higher-brain death, organ donation.

Introduction

Over fifty years ago, the Ad Hoc Committee of the Harvard Medical School to Examine the Definition of Brain Death produced ‘A Definition of Irreversible Coma: Report to Examine the Definition of Brain Death’, published in August 1968 in the *Journal of the American Medical Association* (Beecher 1968). After its publication, the Report became authoritative, and its recommendations were incorporated into legislation passed in several American States and countries throughout the world (Jefferson 2019). The 1981 report ‘Defining Death’, of the United States President’s Commission for the Study of Ethical Problems, highlighted the importance of the emergence of a medical consensus around criteria similar to those proposed by the 1968 Harvard Committee (President’s Commission 1981).

In the last decades of the Twentieth Century, the criteria proposed by the Harvard Committee came under careful scrutiny from authors with various views regarding the diagnosis of death; the ensuing debate has resulted in the waning of the influence of the Committee’s recommendations (Veatch 2005). These views cover a wide spectrum, some define death when various brain functions cease, and others maintain that death should not be defined in reference to brain function, but diagnosed when there is an irreversible loss of circulation (Veatch 2005) .

A special issue of the *Hastings Center Report* (HCR), published in November/December 2018, addressed the fifty-year legacy of the Harvard Report on Brain Death by examining questions about different definitions of death, the implications for organ transplantation, and lessons from the case of a patient without brain function (Hastings Center 2018). The studies in this HCR issue reflect the wide diversity of views that characterises the debate on brain death. However, other important perspectives on defining death not discussed in this publication are reviewed in this paper because in many countries the legal definition of death does not follow the recommendations of the Harvard Committee (Jonsen 2003), e.g. in

India and the United Kingdom death may be legally declared the moment brain-stem function ceases (Smith 2015; Shroff and Navin 2018).

Other proposals defining death have not received legislative assent, yet continue to influence the debate; for example, the ‘disaggregator’ view that posits death as a process not an event, and thus, the pertinent question to be answered is when a person ceases to possess moral worth (Halevy and Brody 1993). Another example is Singer’s proposal that death should be declared when patients’ continued lives cease to be of benefit to them and should be diagnosed when they are irreversibly unconscious (Singer 2016).

The Harvard Committee established its criteria without the advantage of posterior developments in neurology and medical technology. Also, it could not anticipate later case studies that have affected the understanding of death. Thus, there is a need to review the Harvard Committee criteria and compare it with current knowledge.

This work presents and appraises perspectives on brain death outlined in the HCR issue, as well as other proposals not presented in that publication. The second section of the study reviews the criteria set-down by the Harvard Committee and some objections made against them. An overview of different perspectives on determining death is given in the third section. Appraisals of all these perspectives are documented in the fourth section, followed by analyses of the merits and shortcomings of the different perspectives presented on diagnosing death. The study concludes with a discussion on current issues on defining death.

The Harvard Committee Report

The recommendations of the Harvard Committee, prompted scrutiny from authors who claimed the criteria to be insufficient both for establishing proper brain death, and for determining the moment when a person should be declared dead.

The title of the Committee's Report indicates that it was convened to examine the definition of brain death, its first sentence is 'Our primary purpose is to define irreversible coma as a new criterion of death' (Beecher 1968, p. 337). The Committee-proposed the following criteria for defining brain death: (1) unreceptivity and unresponsiveness, (2) no movement or breathing, (3) no reflexes, (4) flat confirmatory electroencephalogram (EEG). In addition, 'The validity of such data as indications of irreversible cerebral damage depended on the exclusion of two conditions: hypothermia (temperature below 90 F, 32.2 °C) or central nervous system depressants, such as barbiturates' (Beecher 1968, pp. 337-338). A common inadequacy in the proposed criteria pointed out by critics was the confusion between the terms 'brain death' and 'irreversible coma', noting that these are two distinct conditions (Pallis 1982; Jonsen 2003; Singer 2016).

This Report has been referred to as a 'pastiche, stitching together some medical information, a legal opinion, and a theological statement' (Jonsen 2003, p. 239). Further criticisms were its lack of clarity and of references to any neurological research. 'It is never clear whether "stopping life support to allow death" or whether "stopping respiratory support on a dead body" is the issue' (Jonsen 2003, p. 420). Moreover, it was argued that 'although the title proclaims it and the text constantly states it, the report does not "define" death' (Jonsen 2003, p. 240). Other commentators indicated that the Report's definition of death constituted a breach of the Dead Donor Rule and regarded it as a redefinition of convenience for improper motives. In its favour, it was contended that the criteria allow tissues and organs previously consigned to the grave, to be utilised to rescue the critically ill.

Several critics of the Committee's recommendations alleged that a Utilitarian Ethics underlies its motives for defining brain death as death itself (Giacomini 1997; Belkin 2003; Wijdincks 2003). In an attempt to demonstrate that a Utilitarian Ethics lies beneath the Committee's intent to redefine death, Singer highlighted an earlier draft of the Report stating

that there is a ‘great need for tissues and organs of, among others, the patient whose cerebrum has been hopelessly destroyed, in order to restore those who are salvageable’ (Singer 2016, p. 323). Singer noted that the response to this comment cautioned against the motive ‘to redefine death in order to make viable organs more readily available to persons requiring transplants’ (Singer 2016, p. 323). Veatch appears to attribute utilitarian motives to the Committee, stating ‘They intuited the strategy of “defining” these patients as dead, thus legitimating treatment stoppage’ (Veatch 2018, p. 6). He asserts the Committee’s pronouncements were a further attempt to ‘address controversy over obtaining organs for transplant’ (Veatch 2018, p. 6).

A comprehensive historical investigation that encompassed ‘a substantial archive of correspondence and iterative drafts of the Report in the Beecher Archive at the Countway Library of Medicine’ (Belkin 2018, p.11) concluded that there has been ‘a significant mischaracterisation of the Committee’s motives’ (Belkin 2018, p.10), and reasoned that the Committee adopted an alternative approach to ethics (Belkin 2018), not utilitarian, but pragmatic. ‘From a pragmatic perspective, something emerges as an ethical problem because of a gap somewhere else’ (Belkin 2018, p.11). In this view, such a gap emerged for the Harvard Committee the moment that vital functions could be maintained resulting from the use of respirators.

This investigation claims that there was concern in the Committee that medical advances were blurring the distinction between therapeutic and nontherapeutic actions in Medicine. It suggests that far from being utilitarian in its motives, the Committee understood that medical practice is inherently experimental and required a clearly defined moment when no further therapeutic benefit could be conferred on the body. This moment then demarcates when for example, it would be ethical, to harvest organs. The study concludes that pragmatically, the loss of whole brain function was the moment when no further therapeutic

benefit could be conferred on a patient, and thus provided a moment when to diagnose death Belkin (2018).

Criticisms of the Harvard Committee Report prompted the search for alternative formulations when human death should be diagnosed. The next section discusses some perspectives that aimed at overcoming perceived inadequacies in the Committee's recommendations.

Proposals on Diagnosing the Moment of Death

The HCR special issue includes three alternative proposals of how death should be defined. Bernat defends the whole-brain criterion of death that was influential on the President's Commission's publication *Defining Death*. Shewmon espouses a definition of death that focuses upon the loss of bodily integration at the organ level. Veatch advocates a 'higher-brain' definition of death, which occurs the moment neocortical function ceases, an event that may occur well before all active bodily functions halt.

Influential views on diagnosing human death not mentioned in the HCR special issue include the proposal that death should be diagnosed when all function of the brain-stem has ceased (Pallis 1982); the disaggregator perspective on death that addresses when it is ethically proper to remove a patient's organs (Truog 1997; Youngner and Arnold 2001); and the 'loss of personal benefit' criterion (Singer 2016).

Proposals discussed in the Hasting Center Report Issue

Whole-brain Death as a Criterion of Death

A brief study by Bernat defends the 'whole-brain' criterion to diagnose death in line with the Harvard Committee recommendations (Bernat 2018). It states that the 'defense of the

concept of brain death has evolved' (Bernat 2018, p. 19). Initially, it was 'the permanent cessation of functioning of the organism as a whole' (Bernat 2018 p. 19). Bernat and co-workers established in 1981 a common framework for discussing the diagnosis of death (Bernat *et al.* 1981). The initial understanding of death was slightly modified to 'the permanent cessation of the critical functions of the organism as a whole' (Bernat 1999, p. 86), and later updated to include: (1) a definition of death as the permanent cessation of the critical functions of the organism as a whole; and (2) a criterion of death as the permanent cessation of the critical functions of the brain (Bernat 2002).

The phrase 'organism as a whole' was coined to explain that living organisms are qualitatively greater than the mere collection of their parts (Bernat 2018). In this view, a living organism spontaneously generates 'critical emergent functions' that create its unity and wholeness (Bernat 2018). 'An emergent function is a property of a whole that is not possessed by any of its component parts, and that cannot be reduced to one or more of its component parts.' (Bernat 2013, p. 424). 'Criticality refers to the extent to which a given function of the organism as a whole is necessary for the continued health and life of the organism' (Bernat *et al.* 1981, p. 86). Examples of 'emergent functions' are consciousness, the control of circulation, respiration and temperature necessary for cellular metabolism, and the systems involving receptors, control centres and effectors integrated in feedback loops to maintain homeostasis (Bernat 1998). The incorporation of the term 'organism as a whole' prompted the acceptance of loss of integration caused by loss of brain function, as a definition of death.

To diagnose death, serial neurological examinations over a time interval (determined by a patient's age and cause of brain injury) are necessary unless a confirmatory laboratory test is used (Bernat 2005). Two widely available and reliable tests were recommended to demonstrate that intracranial blood flow has stopped: intravenous cerebral isotope angiography and transcranial Doppler ultrasound (Bernat 2006). These are 'useful to expedite brain death

determination when organ donation is planned or when clinical tests cannot be performed adequately' (Bernat 2005, p. 374).

Notable attempts have been made to align clinical tests with the neurological criteria proposed by Bernat. In 2010, a subcommittee of the American Academy of Neurology assessed its 1995 guidelines that sought to establish clinical tests to determine whole-brain death (Wijdicks *et al.* 2010). It found that, 'In adults, there are no published reports of recovery of neurologic function after the diagnosis of brain death using the criteria reviewed in the 1995 American Academy of Neurology practice parameter' (Wijdicks *et al.* 2010, p. 1911).

The Circulatory-respiratory Criterion of Death

The circulatory-respiratory perspective supported by Shewmon (1997, 1998a, 2009) holds an integrationist view regarding diagnosing the moment of death, but rejects that cessation of whole-brain function represents the moment when the integrative unity of the body has been irreversibly lost. 'Far from constituting a "central integrator," without which the body reduces to a mere bag of organs, the brain serves as a modulator, fine-tuner, optimiser, enhancer, and protector of an implicitly already existing, intrinsically mediated somatic unity' (Shewmon 1998b, p. 140). This perspective is referred to also as the somatic criterion to define death.

In this understanding of life, interactions between parts of the body, even without brain function, imply that the body is still operating as an integrated whole. It challenges the assumptions that (1) the brain is the body's 'critical system'; and (2) the body has a localised 'critical system' (Shewmon 1998b). The criterion advocated for establishing death as the loss of integration at the organ level, asserts that integration should be understood as 'a non-localized, holistic property founded on the mutual interaction among the parts of the body' (Shewmon 1998b, p. 140).

Death is analysed at three conceptual levels: the definition of death, its criterion, and the tests used to determine it. Death is ‘the loss of integrative unity of the body’ (Shewmon 1998a, p. 1544) shifting the criterion for death away from the brain, and reflecting ‘a critical degree of molecular-level damage (not yet grossly detectable) throughout the body, beyond a thermodynamical “point of no return”’ (Shewmon 1998b, p. 141). This condition requires ‘supracritical damage of enough cells of different types that the body as a whole loses its intrinsic ability to counteract entropy...’ (Shewmon 1998b, p. 141). The clinical test is ‘sustained cessation of circulation of oxygenated blood’ (Shewmon 1998b, p. 142). Since circulation and chemical respiration are essential for life, it is concluded that this definition of death represents a conceptual advance that brings a criterion and tests for death more in line with the traditional notion of death as heralded by asystole (Shewmon 1998b).

Two patient cases emerged to support Shewmon’s arguments. The first was that of TK, who was diagnosed brain-dead when he was four-years-old, and died in 2006 as a fully grown individual (Repertinger 2006). Some authors accepted that TK’s brain may have been completely destroyed, and yet his body continued to function at the organ level for over a decade (Repertinger 2006; Austriaco 2016). However, others asserted that TK was diagnosed by the American Medical Association criteria that involve only clinical assessment of loss of brain stem function, and not loss of all brain function (Bernat 2005).

A more recent case concerned a young girl, JMc, who underwent surgery for obstructive sleep apnoea on 9 December 2013. Complications arose from the procedure which led to a major haemorrhage followed by cardiac arrest. The young girl was resuscitated but suffered brain damage in the process. A later examination involving an EEG resulted in a diagnosis of brain death and she was declared brain-dead on 12 December 2013 at Children’s Hospital Oakland, California (Truog 2018). The patient was transferred to a New Jersey hospital and afterwards to an apartment. This State’s legislation prohibits determination of

death by the Harvard criteria when it would violate the religious beliefs of an individual (Truog 2018). Four years after her transferral to New Jersey, JMc developed liver failure and suffered an unexplained bleeding. At this point her mother decided to withdraw all life support, following which JMc had a cardiac arrest and was declared dead according to New Jersey law on 22 June 2018, thus giving her two death certificates in two different American States that have different legislations regarding when death should be pronounced.

Throughout her unconscious life ‘She continued to grow, began having menstrual periods, and was relatively stable but for a few intercurrent hospitalizations’ (Truog 2018, p. 71). Shewmon contends that despite satisfying the criteria for brain death, JMc deterioration after the diagnosis of brain death was attributable to four weeks of no nutrition and untreated thyroid and adrenal insufficiency, and not to a previous proper death. Moreover, he points to evidence of hypothalamic function, demonstrated by three documented menstrual periods, that should be considered indication of an organism functioning as a whole (Shewmon 2018).

If it could be accepted that the described test cases involved living persons with no brain activity to produce critical emergent functions, death defined by the circulatory-respiratory criterion may possibly be accepted as the most cogent perspective of death, especially if death is regarded as an event, not a process.

The Cessation of Higher-brain Functions as a Criterion of Death

Veatch espouses a version of a higher-brain definition of death in which: ‘...the most plausible focus is on irreversible loss of consciousness and the related claim that death is the irreversible loss of integrated function of body and mind’ (Veatch 2018, p. 6).

Considering that the intention of the Harvard Committee was to declare someone dead once that person has irreversibly lost consciousness, he proposes that a person is dead the moment higher-brain functions irreversibly cease, before all active bodily functions stop.

Veatch identifies the properties of life as ‘the individual’s personality, his conscious life, his uniqueness, his capacity for remembering, judging, reasoning, acting, enjoying and so on’ (Veatch 1993, p. 19), and notes that ‘If these are the important functions, the obvious question is why any lower brain functions would signal the presence of a living individual’ (Veatch 1993, p. 19).

This is a nuanced definition of life that in a morally significant sense ‘is the characteristic of all humans with “embodied capacity for consciousness”’ (Veatch 2005, p. 370); it carefully takes into consideration somatic and mental functions: there must exist a functional integration of body and mind for moral standing to be present (Veatch 2005). Thus, a person who is permanently comatose, permanently vegetative, or an anencephalic infant, could be declared dead (Veatch 2005).

Veatch’s definition of death is unique in various ways: applies solely to human beings, views death philosophically and not exclusively biologically, and relies strongly on the philosophical notion of personhood. Its enduring influence perhaps indicates that no traditional viewpoint regarding death is satisfactory in the light of technological advances that assist maintaining bodily functions.

	Whole-brain <i>(Bernat)</i>	Circulatory-respiratory <i>(Shewmon)</i>	Higher-brain <i>(Veatch)</i>
Does it apply solely to human beings?	No	No	Yes
Is death a biological event?	Yes	Yes	No
Is ‘personhood’ relevant?	No	No	Yes
Does it try to develop the historical definition of death?	Yes	Yes	No
Are there defined tests?	Yes	Yes	No

Overview of the main perspectives on defining death.

Other Proposals not discussed in the HCR

The Brain-stem Death Criterion

The UK Conference of Medical Royal Colleges and their Faculties recommended in 1976 to establish death by the loss of brain-stem function. It acknowledged that the Harvard criteria ‘have provided considerable help’ and that these ‘have been refined as the knowledge gained from experience has been collected’ (Academy of Medical Royal Colleges 1976, p. 1187).

The conditions for considering brain-stem death were: (1) the patient must be deeply comatose; (2) the patient is maintained on a ventilator because spontaneous respiration had previously become inadequate or has ceased altogether; (3) the patient’s condition must be due to irremediable structural damage (Academy of Medical Royal Colleges 1976).

The tests to establish brain-stem death involved diagnosing the absence of all brain-stem reflexes. These included observing pupil-response to sharp changes to the intensity of incident light, the absence of corneal reflexes, the loss of vestibulocochlear reflexes, no presence of motor responses within the cranial nerve distribution, the undetectability of gag reflexes, and the patient being unable to respire for a defined period when detached from a ventilator (Academy of Royal Medical Colleges 1976, p 1187).

A Code of Practice for the Diagnosis and Confirmation of Death was promulgated by the Academy of Medical Royal Colleges in 2008 to update the former guidelines. It listed similar diagnostic criteria for determining brain-stem death published in 1976, and further recommended an apnoea test be performed, but only following all other examinations (Academy of Medical Royal Colleges 2008).

This definition of death as ‘the irreversible loss of the capacity for consciousness combined with the irreversible loss of the capacity to breathe’ (Pallis 1982, p.1488) is regarded as a natural development from that of the Harvard Committee since the criteria that the patient

be unresponsive and unreceptive are fulfilled the moment brain-stem death is established; thus, this is the way to diagnose death (Pallis 1982). The core of this argument is that brain-stem death ‘inevitably heralds asystole’ and this would reassure ‘those who still believe that “real death” is the cessation of the heart beat’ (Pallis 1983, p. 123). This thinking was informed by two Minnesota neurosurgeons, who claimed that irreversible damage to the brain stem signified a ‘point of no return’ (Mohandas and Chou 1971).

To accept the notion that the loss of all brain-stem function signifies the moment of human death entails two conceptual steps. The first is from ‘classical’ death to whole brain death; the second involves accepting that brain-stem death is a ‘necessary and sufficient component of whole brain death’ (Pallis 1982, p. 1488). This definition is influential because it can be ‘linked’ to other definitions of death. For those who define death as the irreversible cessation of circulation, loss of brain-stem function inevitably heralds asystole (Pallis 1983); for those who accept the criteria of the Harvard Committee, brain-stem death is sufficient to meet those criteria.

The recommendations of the 2008 President’s Council on Bioethics provided similar criteria for establishing death namely, that a patient may be declared dead once the ability to breathe spontaneously and interact with the surrounding environment are irreversibly lost (President’s Council 2008). However, the Council utilised a different conceptual logic to arrive at its conclusions, it adopted a new mode-of-being perspective stating ‘the patient with total brain failure is no longer able to carry out the fundamental work of a living organism. Such a patient has lost –and lost irreversibly– a fundamental openness to the surrounding environment as well as the capacity and drive to act on this environment on his or her own behalf’ (President’s Council 2008).

The Disaggregator Criterion of Death

This perspective regards death as a process and what is morally relevant is a proper understanding of when it is ethical to remove a patient's organs (Veatch 2005). It is associated with a study published by Halevy and Brody (1993) that poses three basic clinical questions that have defined engagement with the topic of defining death: (1) When can care be unilaterally withheld? (2) When can organs be harvested? (3) When can the undertaker begin his services? They 'propose that each of the three above-mentioned clinical questions be answered on its own merits, with the realization that the three answers are not necessarily the same. We repudiate the attempt to answer all of them with a single definition of death' (Halevy and Brody 1993, p. 524). Death is regarded as a process and not a single event; consequently, trying to pinpoint a single moment to pronounce death always will produce undesirable outcomes.

To answer to the first question, they articulate a utilitarian perspective that considers death as happening along a continuum of events: 'irreversible coma of conscious functioning is a point on the continuum where the need to rationally use societal resources outweighs the desires of some persons for unlimited care. In such cases, the question of the unilateral withholding or withdrawing of care can be answered without any appeal to a criterion for death' (Halevy and Brody 1993, p. 524). To the issue when organs could be harvested, they answer it 'should center around the attempt to balance the advantage of lives saved through increased organ availability (which argues for harvesting organs in such cases) against the need for public acceptance of organ donation (which may require forgoing harvesting organs in such cases)' (Halevy and Brody 1993, p. 524). Thus, they propose that a 'combination of irreversible cessation of conscious functioning with apnea is the appropriate point on the continuum for organ harvesting' (Halevy and Brody 1993, p. 524). In answer to the last question, they conclude that the moment when a cadaver may be taken to the undertaker is provided by

‘classic criteria of irreversible cessation of respiration and circulation’ (Halevy and Brody 1993, p. 523).

The term ‘disaggregator’ was used to describe this approach to defining death (Veatch 2005). Rather than answering the above three questions with the one criterion, they are unbundled –‘disaggregated’– and each question is answered according to different criteria (Veatch 2005). Death is not a single moment, it is a process comprised of different events, and what becomes relevant in the utilitarian calculus of Halevy and Brody, is how one should act during each moment of the death process.

The Loss of Personal Benefit Criterion of Death

Singer does not ‘disaggregate’ different ‘death events’, but rather addresses the question: when is it permissible for doctors intentionally to end the life of a patient? He responds ‘when the patient’s continued life is of no benefit to her’ (Singer 2016, p. 329), and he explains that this happens ‘when the patient is irreversibly unconscious’ (Singer 2016, p. 329). He notes that the Harvard Committee’s recommendations applied only to those who have ‘no discernible central nervous system activity’, and comments that ‘the arguments it put forward for its redefinition of death applied in every respect to patients who are permanently without any awareness, whether or not they have some brainstem function’ (Singer 2016, p. 325).

He regards the loss of the capacity for consciousness and higher brain functions not the conditions to determine death, but to establish when organs can be removed. He advocates the notion that ‘it is not really the “integrative” or “co-ordinating” functions of the brain that make its death the end of everything we value, but rather its association with our consciousness and our personality’ (Singer 1994, p. 32), and argues that ‘the brain functions that really matter are those related to consciousness’ (Singer 2016, p. 325). Thus, his criterion for legally diagnosing

death is that the person ceases to matter morally. ‘On this view, what we really care about – and ought to care about– is the person rather than the body’ (Singer 2016, p. 325), and ‘Accordingly, it is the permanent cessation of function of the cerebral cortex, not of the whole brain, that should be taken as the criterion of death’ (Singer 2016, p. 325). For him, the question of when a human being dies, ‘suddenly becomes much less relevant to the concerns that the Harvard Brain Death Committee was trying to address’ (Singer 2016, p. 329).

Assessment of different Perspectives regarding the Diagnosis of Death

Notwithstanding the influence of the various perspectives on death, the debate on defining death has been shaped principally by three positions: the whole-brain death criteria, the irreversible loss of circulation heralded by asystole, and the loss of higher-brain function. Each of them has been criticised on perceived inadequacies in their understanding of death; this section discusses some of these assessments.

Appraisal of the Whole-brain Death Criterion

Arguments opposing the definition of death by the whole-brain criterion have focused on case studies such as those involving TK and JMc, that suggest the existence of some bodily integration that manifests signs of life. ‘The current whole-brain law implies that if one minor function survives, then the individual is alive, but without it, the individual is deceased. (...) ‘Can this view, taken literally, be defensible?’ (Veatch and Ross 2016, p. 59).

Shewmon rejects brain death as the criterion to diagnose death and concludes that the Harvard Committee’s rationale was ‘legal utility: it would free up beds in intensive care units and facilitate organ transplantation’ (Shewmon 2009, p. 18). He criticised the Committee’s lack of ‘diagnostic criteria for irreversible cessation of all brain functions’ and absence ‘of any

generally accepted philosophical rationale for why irreversible non-function of the brain should constitute death' (Shewmon 2009, p. 18).

Truog claims that brain death is a legal definition determining the non-living status of people; thus, brain death itself is not a 'biologically plausible definition' but rather 'a social construction not grounded in biological reality' (Truog and Miller 2014, p. 9). He recommends a sharp distinction be made between legal and biological categories. The law demands certainty and thus attempts to draw a clear distinction between life and death, one such legal category is brain death. Persons in the situation of JMc may satisfy the American legal standard for death, but 'these children are often biologically similar to those who are just above the line' (Truog 2018, p. 72).

Singer describes defining death by the cessation of all brain activity to be an 'odd' and 'convenient fiction' (Singer 1994, pp. 20, 35). To support this, he cited a 1986 study published in *Neurosurgery* that found various bodily functions of brain-dead people that could be successfully regulated for an average of 21 days with the supplementation of an antidiuretic hormone. Also, he cited the case of a woman whose body was maintained biologically functioning for over 90 days following brain death, enabling the remarkable delivery of a child (Singer 1994).

Appraisal of the Circulatory-respiratory Criterion of Death

The circulatory-respiratory understanding of death has the advantage that those who regard death as a single event, do not deny that death has occurred with the irreversible cessation of circulation.

A basic problem with this criterion is that 'relatively little is known of brain activity following cardiopulmonary arrest' (Hanley 2020, p. 186), and there is an absence of evidence-based guidelines to establish the period of time to wait before the declaration of death. Many

protocols fail to specify this time interval, and in places where it is settled there is considerable variability within and between countries. In Australia, New Zealand and the United States this time could be as short as 2 minutes, whereas Italy and Sweden use intervals of 20 minutes by several authorities (Dhanani *et al.* 2010). A rationale for the longer waits is that shorter periods do not ensure irreversible loss of brain function and will transform the Death Donor Rule into the 'Dying Donor Rule' (Italian National Bioethics Committee 2010).

A factor that influences the variability of waiting periods is the prospect of organ donation, and many concerns have been raised about donation after cardiac death (DCD). A comprehensive review of this matter concludes: 'With neither cardiac nor neurological function being irretrievably lost until after many minutes of asystole, it seems that many, if not all cases of DCD May involve organ donation from patients who are not biologically dead' (Souter and Van Norman 2010).

Appraisal of the Higher-brain Function Criterion of Death

The definition of death based on the cessation of higher-brain function has been criticised for departing from what traditionally has been understood as death, for being applicable only to human persons, and for relying more on questionable philosophy than biology. Bernat and colleagues maintain this definition does not account for what is commonly meant by the term 'death', which they assert is a 'biological concept' (Bernat *et al.* 1981, p. 390). Also, they regard the concept of person as non-biological and conclude that the higher-brain definition of death 'states what it is for an organism to cease to be a person rather than stating what it is for that organism to die' (Bernat *et al.* 1981, p. 390). In their view 'personhood is an inherently vague concept, strict criteria for its loss are difficult to identify' (Bernat *et al.* 1982, p. 6). They highlight that the higher-brain formulation of death applies exclusively to human beings and not to other species, whereas the traditional concept of death is the same for

the death of other species, such as a cat or dog (Bernat 1984). A note of caution has been added indicating that the higher-brain definition of death ‘moves death into the subjective realm, where profound disability may permissibly and arbitrarily override biological reality’ (Hanley 2020, p. 32)

Declaring chronic vegetative patients as dead could lead to potential problems. ‘Persistent-vegetative-state patients form a continuum from those rare cases of complete neocortical destruction...to the more common cases resulting from trauma, stroke, and diffuse hypoxic-ischemic insults in which the degree of brain damage is variable and prognosis therefore is less clear’ (Bernat 1992, p. 23). The higher-brain function view of death introduces the question: How much neocortical damage is necessary before we declare a patient dead? (Bernat *et al.* 1982), and a hypothetical slippery slope has been signaled ‘If patients in persistent vegetative states were considered dead, perhaps so too should severely demented patients because they too lack experiential and social integrative functions’ (Bernat 1998, p. 17).

It has been noted that patients with neocortical damage but retaining brain-stem function, continue to breathe spontaneously (Bernat 1984), and patients in a persistent vegetative state ‘continue to breathe, have autonomous heartbeat, can make sounds and movements, and demonstrate primitive protective reflexes to maintain clear airways’ (Bernat 1992, p. 23). Thus, a question was posed whether it’s possible that a patient could be buried with still be able to breathe unassisted, if not, before burial ‘how would the vital functions be stopped and by whom?’ before burial (Bernat 1984, p. 47).

The higher-brain formulation of death has been criticised also for having no recognisable tests for its determination ‘because it has achieved no medical or legal acceptance’ (Bernat 2005, p. 374).

Reflections on Defining and Diagnosing Death

The recommendations of the Harvard Committee were a pragmatic effort to understand death in the light of scientific and technical advances that at the time blurred the distinction between life and death, as well as that between death and unresponsive coma. The Report created a controversy about insufficient criteria to determine brain death; debates focused on the ‘great confirmatory value’ of the EEG that was singled out for criticism. Nonetheless, the importance of EEG monitoring in diagnosing death needs to consider that decisions to withdraw life support therapies rely on the ability of individuals to follow commands shortly after brain injury (Elmer *et al.* 2016), and the presence in larger numbers than previously thought of cognitive motor disassociation between behaviour and EEG responses of unresponsive patients with severe brain trauma underlines (Classen *et al.* 2019).

Different proposals on diagnosing death that followed discussions of the Harvard Report yielded a better understanding of how death could be defined and determined medically and legally. It suffices to consider Bernat’s outline of a ‘paradigm of death’ (Bernat 2006), and Shewmon’s (1998a; 1998b) documentation of ‘signs of life’ in ‘brain-dead’ patients, that provided evidence against this definition.

Bernat’s analysis was an attempt to define what has been conventionally understood as death bringing into consideration the development of new technologies. He argued that most people at all times in history, would agree that death has occurred at hanging or decapitation. Parts of the body may continue briefly to function, but the capacity to recover ‘critical functions’ that help continue and perpetuate life are irretrievably lost (Bernat 2002). Shewmon’s questioning of the definition of death only in neurological terms does not lead to necessary acceptance of the circulatory-respiratory definition of death.

Truog noted that on rare occasions the condition of people sometimes fell below the legal criteria of brain death and later raised above it. In his view, this demonstrated an inability

to determine death biologically as the moment when certain bodily functions are irretrievably lost. However, this reasoning shows only the inadequacy of the brain death definition, but not that at a given moment death has occurred.

Regarding the criteria to establish death, Shewmon and Veatch uncovered a potential flaw in Bernat's analysis, namely, the non-inclusion of tests of hypothalamic activity to diagnose brain death; an assessment required to show that 'critical functions' such as temperature control are irretrievably lost. However, Bernat touched upon the value of establishing the absence of circulation by neural imaging employing an ultrasound apparatus that could demonstrate absence of intracranial blood flow. At the same time, the criterion of the cessation of circulatory and respiratory functions criterion proposed by Shewmon has its own problems because it is possible artificially to maintain the circulation of oxygenated blood which could result in the maintenance of some other bodily functions, and this situation does not necessarily mean that the patient is alive.

A significant recent contribution to the definition and diagnosis of death is the report *Determination of Brain Death/Death by Neurologic Criteria: The World Brain Death Protect* (Greer *et al.* 2020) created by several international professional societies and based on a review of the literature on the subject published between 1992 and 2017. It proposes minimum standards for diagnosing brain death and received widespread endorsement. The Report acknowledges that the lack of high-quality data from randomized clinical trials or large observational studies limits its analyses.

The Report recommends that 'brain death' be understood as 'the complete and permanent loss of brain function as defined by an unresponsive coma with loss of capacity for consciousness, brainstem reflexes, and the ability to breathe independently' (Greer *et al.* 2020, p. E4). The document suggests that the terms whole brain death and brainstem death be abandoned and replaced with 'brain death' or 'death by neurological criteria' (BD/DNC). The

rationale is that the clinical diagnosis of whole-brain death or brainstem death typically leads to the same conclusion, ‘differing only in the rare case of isolated primary brainstem or posterior cerebral circulation pathology’ (Greet *et al.* 2020, p. E4). The Report acknowledges that brain-stem death and whole-brain death are distinct concepts, and that in some instances a proper diagnosis of whole-brain death requires more stringent measures. The BD/DNC criteria have limitations because ‘there remains a possibility that a person whose brain stem is destroyed but who nonetheless retains some higher-brain functions could be declared dead in the United Kingdom but not in the United States’ (Hanley 2020, p. 35). Countries such as France, Italy, Spain and Singapore have legislated a ‘four vessel test’ that measures blood flow in the right and left carotid and vertebral arteries, the test requires that there be zero blood flow ascertained by angiography after contrast dye has been injected into the blood vessels supplying the brain (Tonti-Filippini 2012).

In the BD/DNC determination of death, to establish the absence of brain blood circulation is regarded as an ancillary test. The Report states: ‘if an assessment for BD/DNC is being made in a region that equates “whole brain death” with BD/DNC, in the setting of an isolated brainstem lesion or posterior circulation vascular lesion, ancillary testing should be performed. In these circumstances, it is suggested that BD/DNC should not be diagnosed until supratentorial and infratentorial blood flow is lost, even if the clinical examination and apnea test are suggestive of BD/DNC’ (Greer *et al.* 2020, p. E5). This approach is consistent with the view that ‘although the absence of cerebral blood flow is a reliable indicator of death, a person may be dead even with a measure of cerebral blood flow (Hanley 2020, pp. 26-27).

In addition, a recent study casts doubt on the appropriateness of diagnosing death according to the absence of brain circulation. Vrselja *et al.* (2019) developed a method capable of restoring brain circulation and cellular functions for hours post-mortem in pigs. They restored various properties of the brains and conclude that ‘the large mammalian brain retains

an underappreciated capacity for normothermic restoration and microcirculation and certain molecular and cellular functions multiple hours after circulatory arrest' (Vrselja *et al.* 2019, p. 336). Further investigations must be conducted to ascertain the validity of these results, since objections have been raised that: (1) the lack of EEG activity reported could be the result of the researchers using chemical agents that inhibit neural activity, (2) the use of tissues slices is inadequate for addressing questions about function and global activity, and (3) there was no evidence of higher-brain function of the type associated with consciousness, nor the capacity to perceive the environment and experience sensations (Farahany *et al.* 2019).

The discovery that mammalian brains can be made to seem 'slightly alive', hours after the animals had been killed, has implications that ethicists, regulators and society more broadly must now think through. (Bioethics Observatory 2019). The discovery of the restoration of brain circulation hours post-mortem could change current paradigms of death criteria (Farahany *et al.* 2019), and will inform the debate on defining death moving into the future.

The current practice of organ donation after determination of circulatory death as a way to expedite the time to establish death represents 'a departure from the unitary concept of death, a violation of the death donor rule, and a challenge to the standard of irreversibility. Attempts to redefine the determination of death from an irreversibility standard to a permanence standard have significant impact on the social contract upon which deceased donor organ transplantation rests, and must entail broad societal examination. The determination of death is best reached by a clear, strict, and uniform irreversibility standard. In deceased donor organ transplantation, the interests of the donor as a person are paramount, and no interest of organ recipients or of the greater society can justify negation of the rights and bodily integrity of the person who is a donor, nor conversion of the altruism of giving into the calculus of taking' (White III 2019, p. 366).

A recommendation of the Report is that the persistence of hormonal regulatory function does not preclude diagnosing BN/DNC (Greet *et al.* 2020, p. E4), at variance with Shewmon's view that evidence for hypothalamic function is an indication of an organism functioning as a whole and hence not dead (Shewmon 2018).

The Report identifies appropriate bedside examinations for determining absence of brain-stem function, and how to eliminate the influence of confounders that might inhibit a proper diagnosis of brain-death. Practitioners seeking to establish whole-brain death need to keep in mind the need to incorporate additional tests described as 'Ancillary tests', such as digital subtraction angiography.

A limitation is its derivative method that relies on finding consensus among the literature and existing guidelines, such as those set forth by the 2008 President's Council, the Academy of Royal Medical Colleges in 2008 and the American Academy of Neurology guidelines updated in 2010 (Wijdicks 2010).

Conclusion

More than 50 years since the publication of the Harvard Committee Report on defining death, there remains a diversity of opinions regarding how death should be defined and diagnosed. Its influence is reflected in the spectrum of opinions it generated. This review has discussed and appraised opinions on determining death advanced in the last five decades.

The legal requirements of declaring a person dead necessitate to have at any point in time a definition and a set of indicative tests for certifying irreversible loss of general homeostasis. Developments in our knowledge of human biology, medical technology, and diagnosing techniques impinge on the definition and determination of death. Concepts such as loss of integration of the whole organism, loss of autonomy and loss of personhood have resulted in an evolution of medical and legal understandings of death (Souter 2010). These

considerations imply that it would be possible to clarify these understandings as our knowledge progresses.

The recent attempt to recommend a code of minimum standards for determining death (Greer *et al.* 2020) and an in-depth analysis of neurological criteria to determine death (Hanley 2020) provide firm foundations to determining death based on current knowledge. It is open to future experts to decide how these perspectives should be integrated into future discussions on defining and diagnosing death.

References

- Academy of Medical Royal Colleges, 2008. *A Code of Practice for the Diagnosis and Confirmation of Death*. Available from: https://www.researchgate.net/profile/Alex-Manara/publication/313214230_A_code_of_practice_for_the_diagnosis_and_confirmation_of_death/links/5895f70b92851c8bb67cb030/A-code-of-practice-for-the-diagnosis-and-confirmation-of-death.pdf [Accessed 3 August 2020].
- Austriaco, N.P., 2016. A philosophical assessment of TK's autopsy report: Implications for the debate over the brain death criteria. *The Linacre Quarterly*, 83 (2): 192-202.
- Beecher, H.K., 1968. Report of the Ad Hoc Committee of the Harvard Medical School to Examine the Definition of Death. A Definition of Irreversible Coma. *Journal of the American Medical Association*, 205 (6): 337-340.
- Belkin, G.S. 2003. Brain death and the historical understanding of Bioethics. *Bulletin of the History of Medical Allied Sciences*, 58 (3): 325-361.
- Belkin, G.A., 2018. Path not taken: Beecher, brain death, and the aims of Medicine. *Hastings Centre Report*, 48 (6): 10-13.

- Bernat, J.L., 1984. The definition, criterion, and statute of death. *Seminars in Neurology*, 4 (1): 45-51.
- Bernat, J.L., 1992. How much of the brain must die in brain death? *The Journal of Clinical Ethics*, 199 3 (1): 21-6.
- Bernat, J.L., 1998. A defense of the whole-brain concept of death. *Hastings Centre Report*, 28 (2): 14-23.
- Bernat, J.L., 1999. Refinements in the definition and criterion of death. In: S.J. Youngner Editor, R.M. Arnold Editor, and R. Schapiro Editor, eds. *The definition of death*. Baltimore: The Johns Hopkins University Press, 83-92.
- Bernat, J.L., 2002. The biophilosophical basis of whole-brain death. *Social Philosophy & Policy*, 19 (2): 324-342.
- Bernat, J.L., 2005. The concept and practice of brain death. In: S. Laureys Editor. *The boundaries of consciousness: Neurobiology and Neuropathology*. Amsterdam: Elsevier, 369-380.
- Bernat, J.L., 2006. The whole-brain concept of death remains optimum public policy. *The Journal of Law Medicine and Ethics*, 34 (1): 35-43.
- Bernat, J.L., 2013. The definition and criterion of death. In: J.L. Bernat Editor, and R. Beresford Editor, eds. *Ethical and Legal Issues in Neurology*. Amsterdam: Elsevier, 419-436.
- Bernat, J.L., 2018. A conceptual justification of brain death. *Hastings Centre Report*, 48 (6): 19-21.
- Bernat, J.L., Culver, C.M., and Gert, B., 1981. On the definition and criterion of death. *Annals of Internal Medicine*, 94 (3): 389-394.
- Bernat, J.L., Culver, C.M., and Gert B., 1982. Defining death in theory and practice. *Hastings Centre Report*, (12) 1: 5-9.

Bioethics Observatory, 2019. The discovery of the restoration of brain circulation hours post-mortem could change current paradigms of death criteria. *Institute of Life Sciences UCV*. Available from: [\[http://bioethicsobservatory.org/2019/07/organ-donation-current-death-criteria/31555\]](http://bioethicsobservatory.org/2019/07/organ-donation-current-death-criteria/31555) [Accessed 28 September 2019].

Claasen, J., *et al.*, 2019. Detection of brain activation in unresponsive patients with acute brain injury. *The New England Journal of Medicine*, 380 (26): 2497-2505.

Conference of Medical Royal Colleges and their Faculties in the United Kingdom on 11 October 1976. Diagnosis in Brain Death. *British Medical Journal*, 1976 (2): 1187-8.

Dhanani, S., *et al.*, 2012. Variability in the determination of death after cardiac arrest: A review of guidelines and statements. *Journal of Intensive Care Medicine*, 27 (4): 238-252.

Elmer. L., *et al.*, 2016. Mortality associated with withdrawal of life-sustaining therapy for perceived neurological prognosis with mortality after cardiac arrest. *Resuscitation*, 102: 127-135.

Farahany, N.A., Greely, H.T., and Giattino, C.M. 2019. Part-revived pig brains raise slew of ethical quandaries. 2019. Available from: <https://www.scientificamerican.com/article/part-revived-pig-brains-raise-slew-of-ethical-quandaries/>) [Accessed 28 September 2019].

Giacomini, M., 1997. A change of heart and a change of mind? Technology and the redefinition of death in 1968. *Social Science & Medicine*, 44 (10): 1465-1482.

Greer, M.D., *et al.*, 2020. *Determination of Brain Death/Death by Neurologic Criteria: The World Brain Death Project*. Available from: <https://jamanetwork.com/journals/jama/fullarticle/2769149> [Accessed 20 August 2020].

Halevy, A., and Brody, B., 1993. Brain death: reconciling definitions, criteria, and tests. *Annals of Internal Medicine*, 119 (6): 519-525.

Hanley, M., 2020. *Determining Death by Neurological Criteria*. Philadelphia: The National Catholic Bioethics Center.

Hastings Centre Report 2018. 48 (4).

Italian National Bioethics Committee, 2010. Criteria for ascertaining death. *Opinion, June 24*. <http://bioetica.governo.it/> [Accessed 20 August 2020].

Jefferson, R.S., 2019. *What does “dead” mean? The debate continues some 50 years after Harvard defined death.* Available from: <https://www.forbes.com/sites/robinseatonjefferson/2019/01/16/what-does-dead-mean-the-debate-continues-some-50-years-after-harvard-defined-death/#51105fb94a22>. [Accessed 27 September 2019].

Jonsen, A.R., 2003. *The Birth of Bioethics*. Oxford: Oxford University Press.

Mohandas, A., Chou, S.N., 1971. Brain death – a clinical and pathological study. *Journal of Neurosurgery*, 35 (2): 211-8.

Pallis, C., 1982. ABC of brain stem death: From brain death to brain stem death. *British Medical Journal*, 285 (6353): 1487-1490.

Pallis, C., 1983. ABC of brain stem death: Prognostic significance of a dead brain stem. *British Medical Journal*, 286 (6361): 123-124.

President’s Commission for the Study of Ethical Problems in Medicine, 1981. *Defining Death: A Report on the Medical, Legal and Ethical Issues in the Determination of Death*. Washington, DC: US Government Printing Office.

President’s Council on Bioethics, 2008. *Controversies in the determination of death*. Available from <https://bioethicsarchive.georgetown.edu/pcbe/reports/death/chapter7.html> [Accessed 28 September 2019].

Repertinger, S., Fitzgibbons, W., Omojola, M.F., and Brumback, R.A. 2006. Long survival following bacterial meningitis-Associated brain destruction. *Journal of Child Neurology*, 21 (7): 591-595.

- Shewmon, D.A., 1997. Recovery from “brain death”: A neurologist’s apologia. *The Linacre Quarterly*, 64 (1): 31-96.
- Shewmon, D.A., 1998a. Chronic “brain death”: Meta-analysis and conceptual consequences. *Neurology*, 51: 1538-1545.
- Shewmon, D.A., 1998b. Brainstem death, brain death and death: A critical re-evaluation. *Issues in Law and Medicine*, 14 (2): 125-145.
- Shewmon, D.A., 2009. Brain death: Can it be resuscitated? *Asian Bioethics Review*, 1 (1): 17-28.
- Shewmon, D.A., 2018. The case of Jahi McMath: A neurologist’s view. *Hastings Centre Report*, 48 (6): 74-76.
- Shroff, S., and Navin. S., 2018. “Brain death” and “circulatory death”: Need for a uniform definition of death in India. Available from: http://www.ijme.in/wp-content/uploads/2018/09/20180904_Brain-death.pdf. [Accessed 30 September 2019]
- Singer, P., 1994. *Rethinking life and death: The collapse of our traditional values*. New York: Martin Griffin.
- Singer, P., 2016. Is the sanctity of life ethic terminally ill? In: H. Kuhse Editor, U. Schüklenk Editor, P. Singer Editor, eds. *Bioethics: An Anthology* (3rd Ed.). Chichester: Wiley Blackwell, 321-330.
- Smith, M., 2015. Brain death: The United Kingdom perspective. *Seminars in Neurology*, 35 (2): 145-151.
- Souter, M., and Van Norman, V., G., 2010. Ethical controversies at end of life after traumatic brain injury: Defining death and organ donation. *Critical Care Medicine*, 38 (9): S502-S509.
- Tonti-Filippini, N., 2012. About Bioethics: Transplantation, biobanks and the human body. Ballan: Connor Court.
- Truog, R.D., 1997. Is it time to abandon brain death? *Hastings Centre Report*, 27 (1): 29-37.

- Truog, R.D., and Miller F.G., 2014. Changing the conversation about brain death. *The American Journal of Bioethics*, 14 (8): 9-14.
- Truog, R.D., 2018. Lessons from the case of Jahi McMath. *Hastings Centre Report*, 48 (6): 70-73.
- Veatch, R.M., 1993. The impending collapse of the whole-brain definition of death. *Hastings Centre Report*, 23 (4): 18-24.
- Veatch, R.M., 2005. The death of whole-brain death: The plague of the disaggregators, somaticists, and mentalists. *Journal of Medicine and Philosophy*, 30 (4): 353-378.
- Veatch, R.M., and Ross, L.F., 2016. *Defining death: The case for choice*. Washington DC: Georgetown University Press.
- Veatch, R.M., 2018. Would a reasonable person now accept the 1968 Harvard Brain Death Report? *Hastings Centre Report*, 48 (6): 6-9.
- Vrselja, Z., et al., 2019. Restoration of brain circulation and cellular functions hours post-mortem. *Nature*, 568: 336-343.
- White III, F.J. 2019. Controversy in the determination of death: The definition and moment of death. *The Linacre Quarterly*, 86 (4), 366-380.
- Wijdicks, E.F., 2003. The neurologist and Harvard Criteria for Brain Death. *Neurology*, 61 (7): 970-976.
- Wijdicks, E.F., et al., 2010. *Evidence-based guideline update: Determining brain death in adults*. Available from: <https://n.neurology.org/content/74/23/1911>. [Accessed 22 August 2020]
- Youngner, S.J., and Arnold, R.M., 2001. Philosophical debates about the definition of death: Who cares? *Journal of Medicine and Philosophy*, 26 (5): 527-537.