Arguments Supporting the Whole-Brain Criterion

Michael A. Rubin and Ranier Reyes

Loss of the ability to maintain homeostasis after irreversible circulatory–respiratory failure is the traditional medical definition of death, and with such failure, also comes the loss of neurologic function. Historically, a distinction between circulatory–respiratory and neurologic failure was irrelevant, as in the case of catastrophic neurologic failure, circulatory–respiratory collapse inevitably occurred after cerebral herniation and with it came the same loss of homeostasis. With the implementation of advanced organ support, the distinction between the two became relevant. The order of system failure matters, as we can replace some, but not all organ functions with technology. While the same system loss cascade would occur after catastrophic renal injury if it were not for dialysis, there are essential functions of the nervous system that cannot be replaced in the same way our kidneys can. It is that distinction that justifies the organism to be considered dead by neurologic criteria while there is no such determination by renal criteria. Because technology has significantly altered the consequences of organ failure, a change in our understanding of life and death is warranted; the previous paradigm can no longer be applied in all circumstances. Shifting such a paradigm does not mean we are creating a new ontology; rather, we have revealed a truth that has always existed that just never had sufficient relevance to be contemplated and described.

Earlier chapters of this book reviewed the historical context of determination of death by neurologic criteria and arguments for and against its validity. In this chapter, we expand upon the arguments for the validity of death by neurologic criteria by supporting two claims: (1) a definition of death should be based on a biologic foundation and (2) the only clinically reliable and rationally validated way to support a biologic paradigm of death by neurologic criteria is with the whole-brain criterion. Otherwise, the formulation risks being criticized as a socially created concept based

M. A. Rubin (✉) · R. Reyes
UT Southwestern Medical Center, Dallas, TX, USA
e-mail: Michael.Rubin@utsouthwestern.edu; Ranier.Reyes@utsouthwestern.edu

A. Lewis, J. L. Bernat (eds.), *Death Determination by Neurologic Criteria*,
Advances in Neuroethics, https://doi.org/10.1007/978-3-031-15947-3_4

on a metaphysical argument or an incomplete assessment of essential biologic function rather than an accurate description of the natural world.

The first argument in support of whole-brain criterion does not require much exploration; the whole-brain criterion is the most widely used and generally accepted so that convention is evidence of its value. While the Harvard Ad Hoc Committee did not offer a justification of the use of neurologic criteria to declare death, the subsequent President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research, the Uniform Determination of Death Act (UDDA), and the American Academy of Neurology (AAN) practice parameters evolved the argument supporting the whole-brain criterion by establishing foundational concepts; it was not until recent history that this understanding was criticized and recast by some as motivated by other interests [1–5]. Perhaps consensus among forbearers led to a lack of perception of need to offer such justification or perhaps they were proceeding based on insufficiently explored intuition. Either way, subsequent scholars and policymakers developed an understanding of the concept. Whether by comfort with convention, an intuition-driven worldview, or rational argument, we have found that surveys of clinicians and the general public, as well as endorsements by numerous medical societies worldwide demonstrate that the whole-brain criterion maintains consensus [6–8]. While tradition is not sufficient to support a position on its own, one cannot ignore that this is the standard against which other viewpoints must argue why they are superior.

1 A Definition of Life

Death is universally accepted as an irreversible transition from the state of being alive to being dead. These are mutually exclusive states, with death being the loss of features that defined something as alive. Consequently, before death by neurologic criteria can be described, the requirements of life must be known. Once those are defined, then the key question can be asked: *does death by neurologic criteria satisfactorily indicate a transition from life to death?* When we argue the whole-brain formulation to be correct, we are really arguing that when certain functions of the central nervous system are irreversibly lost, the criteria of life are no longer met, and the organism is now dead.

It would be incorrect to say that a patient who undergoes cardiac bypass surgery requiring cardioplegia was temporarily dead until revived at the end of their surgery. Similarly, if a patient suffers a circulatory–respiratory arrest and is successfully resuscitated, they likewise were never dead. In both cases, the state in question was shown to be reversible. The time of death is assigned using circulatory–respiratory criteria to the moment when the clinician has determined that function is absent and will not return. An interesting distinction between irreversible and permanent has been proposed because of modern resuscitation techniques that require a judgment as to when efforts ought to be stopped due to proven failure in sustainability. This distinction, which is described in detail elsewhere in this book, allows patient, surrogate, and clinician judgment to determine when permanence is morally sufficient

to meet the criteria normally subscribed to irreversible loss of circulatory–respiratory function [9–11].

The property of "living" is defined by features and functions that an organism has and that can be demonstrated. We do not require a pathological examination or the establishment of rigor mortis before we declare death. Such steps might offer greater reassurance, but they deny the cultural and religious norms that require an appropriate legal qualification and burial rights. Consequently, we have determined by consensus what observations are necessary to make a determination of death. Our observation-based declaration leads to the truth that one cannot claim what life *is*, but at most can offer a description of the functions of what a living organism is able *to do*. The current biologic consensus is that living organisms are composed of organic molecules organized into cells, tissues, and organ systems in such a way to utilize energy to maintain homeostasis, respond to the environment, adapt to threats to survival, and complete a generational cycle to reproduce [12, 13].

2 Emergent Properties as an Essential Component of Life

Structural organization allows the ability to compartmentalize and specialize biochemical activities. More importantly, complex organization allows the development of emergent properties: qualities and functions that only exist in the intact organism as a whole [14–18]. Such properties are not localizable in any one place or attributed to a single set of biochemical processes. These properties promote the organism's survival and ability to fulfill the functions of life. Without emergence, the ability to survive is significantly hampered, as evidenced by increasingly complex organisms evolving by natural selection. While "has emergent properties" is not usually listed as a component of life, their presence serves the fulfillment of the other criteria. Specifically, in human beings, consciousness and social behaviors allow protection from threats and the ability to obtain nutrition to maintain homeostasis. A simple thought exercise reveals the necessity of including emergent properties in a definition of life: if one were to place every organ of a human (or any other organism that is composed of more than a single cell) in a jar supported by an adequate milieu to maintain homeostasis, while it is self-evident that these are organic components, the person is no longer a living human organism. Logically speaking, if exclusion of an element of a definition interferes with the integrity of the definition, this element is necessary. When a person fulfills the whole-brain criterion for death, they may maintain some elements of living organisms, but they have lost essential emergent properties, cannot obtain consciousness, cannot respond to the environment, and cannot adapt to new challenges to survival.

The argument of the "organism as a whole" has been supported for decades [2, 13–18]. The "whole" organism possesses specific emergent functions, which are essential for the functioning of the organism and are a product of the collective and unified whole; the permanent cessation of these emergent functions (e.g., control of respiration, circulation, conscious awareness) therefore indicates the organism's death [16]. Centers which are responsible for these emergent properties are

distributed throughout various areas within the brain and brainstem; the whole-brain formulation thus argues for the irreversible loss of function of the entire brain, including the neocortex and brainstem, as a necessity for the determination of death [16, 19, 20]. Crucial to the whole-brain criterion is the understanding that "whole" does not equate to "all" [15, 20]. While there is likely to be activity within some neural cells after death, just as there is some retained cardiac myocyte activity after circulatory cessation, this activity no longer has the ability to significantly contribute to the operation of the organism as a whole without support of technology [20].

3 Homeostasis Is Not Enough

A prominent criticism of the whole-brain criterion is that it requires more than the ability to maintain homeostasis, which some critics argue is the *only true criteria* for death. Others argue that this is a "legal-fiction" created to respect the concept of the "dead donor rule" and permit organ recovery [5]. While this argument is coherent and internally consistent, it falls short in that it limits the biologic definition to one component and excludes (or at least, does not include) the presence of essential emergent properties and the ability to respond to the external environment, adapt to challenges to survival, and grow and procreate. One could counter that if one can maintain homeostasis, the other features can be restored, but in the case of irreversible loss of consciousness and the other adaptive features of the nervous system, such is not the case. One cannot exclude a functioning nervous system (or one that may recover to a functional state) in a definition of human life that includes all the aforementioned features of life. As an extension, the criticism that the comparison of death of a human being qualified differently than death in another mammal or a single-cell organism by requiring the emergent properties of consciousness and awareness falls short, as another criterion is not being applied. Rather the claim is consistent: the loss of emergent properties is part of all definitions of death. Such properties are more complex, however, in a human than other organisms, and therefore are easier to identify when they have been lost.

4 Replacing Systemic Integration Does Not Preclude the Importance of the Brain

An early formulation of death by neurologic criteria included the integrative function of the nervous system as grounds for its veracity. In as much as the nervous system controls and influences other systems through direct stimulation and neuroendocrine control, the irreversible loss of neurologic function would lead to system disintegration and cause further organ system failures in a sequential fashion. While this is partially true, supportive therapies can augment these functions and allow other organs to continue for days to months, or perhaps even years [21]. For example, fluid and sodium balance can be managed with intravenous fluids with various concentrations of salt, and loss of cardiovascular tone and cardiac dysrhythmias can

be modulated by medications. With improvements in critical care, the whole-brain criterion can no longer claim support from the thought that the nervous system is the keystone on which all other systems depend; however, it does not need to be valid. The inherent functions unique to the nervous system are in themselves requisite to fulfill the qualities of a living human person.

5 The Brainstem Criterion and Why It Falls Short

The argument for death by neurologic criteria based on irreversible loss of all brainstem function uses a reductionist approach based on the premise that death involves two features: (1) the irreversible loss of the capacity for consciousness and (2) the irreversible loss of the capacity to breathe [22]. The irreversible loss of brainstem function, regardless of the mechanism of injury, is believed to produce this state. As the center for respiratory drive, hemodynamic regulation, and arousal and wakefulness, the brainstem is essential for life. Nearly all input and output of the brain passes through the brainstem, making it essential in how we respond to environmental or external stimuli and integrate higher cortical function into survival. Many proponents of the brainstem criterion also argue that most clinical tests utilized in determinations of death by neurologic criteria, using either the whole-brain or brainstem criterion, involve the evaluation of brainstem reflexes; the brainstem criterion is therefore pragmatic and easily testable. Lastly, advocates emphasize that loss of brainstem function ultimately leads to circulatory–respiratory arrest and thus appeases those who define death as irreversible cessation of circulation and respiration [18, 22, 23].

Critics of the brainstem formulation point out ways in which it fails to account for the importance of higher-brain function. It fails to account for conscious awareness and plausible scenarios in which this may be preserved via function of the cerebral cortices and thalami. Bernat proposes a hypothetical patient with extensive, but isolated, brainstem damage who may present with brainstem areflexia yet preserved consciousness; this imaginary scenario portraying the most severe version of a "locked-in" patient illustrates a situation in which death by neurologic criteria may be clinically evident based on bedside clinical testing but arousal is preserved in supratentorial structures [20]. With the advent of invasive neurologic probes to treat movement disorders, one can imagine a future in which invasive technology promotes arousal artificially. In theoretical situations of isolated brainstem damage, this would provide an avenue for preserved cortical function to respond to the surrounding environment and to perform the necessary "work" of the human organism. A practical and essential criticism to the brainstem criterion is that pathologies causing isolated obliteration of brainstem function, but with preservation of cortical function, may not dependably be irreversible. In contrast, supratentorial lesions causing catastrophic elevations in intracranial pressure compressing the brainstem will reliably not be reversible. As we have previously stated, the irreversible loss of function is the *sine qua non* of death; therefore, this uncertainty precludes isolated brainstem dysfunction as a reliable means of declaration.

6 The Higher-Brain Criterion and Why It Falls Short

The higher-brain criterion argues that the primary and distinctive function of the human being includes "the individual's personality, his conscious life, his uniqueness, his capacity for remembering, judging, reasoning, acting, enjoying, worrying, and so on," all of which require an intact cerebral cortex [24]. Therefore, death is the "irreversible loss of integrated function of body and mind" and may be conceptualized as the irreversible loss of higher-brain functions [24, 25]. While some dismiss this approach outright as esoteric philosophy, this view has ancient roots and similar arguments have been made based on the works of Aristotle as well as St. Thomas Aquinas [26]. Whether by a rational understanding of the difference between the material and metaphysical or through a religious or spiritual belief in the eternal soul, there is a component of human psychology that intuitively requires the presence (or a least potential presence) of a conscious mind to see someone as living. In these traditions, death is the moment of separation of the physical body from the incorporeal soul; the separation of the temporary mortal self and the eternal self. The irreversible loss of the human nervous system function would extinguish a person's ability to have access to the connection of mind or soul, and therefore qualify as death.

Robert Veatch made an interesting contribution to the literature in his proposal that the debate regarding the definition of death is really a discourse on the loss of moral and legal standing, rather than the moment that one has switched from one biological category to another [27]. The ability of humans to self-identify, form social relationships, and possess "moral status" is essential to promoting survival of the human organism. This position is persuasive and attractive in many ways. First, it defines death (and life) beyond strictly biological means. Given the societal and cultural implications of the determination of life and death, he argues that the definition of human life and death should not be reduced to somatic and biological measures. There is a reason defining death has such a profound impact outside of scientific medicine and permeates through the realms of law, ethics, and the public. Second, it reiterates the idea that the brain possesses something unique to human existence, the loss of which therefore results in death. The capacity for consciousness in concordance with higher functioning (e.g., reasoning, personality, etc.) is a trait unique not only to humans but to living humans, and is housed in the cerebrum. If death by neurologic criteria accepts the irreversible loss of something within the brain that distinguishes human life from exclusively the existence of cells and tissues, it is reasonable to believe this feature is in fact cognition and the ability to integrate body and mind. This understanding is even more compelling given advances in modern medicine which allow for sustenance of bodily functions.

A practical issue of the higher-brain formulation centers on the examples of anencephalic patients or those in a persistent vegetative state/unaware–wakeful state [19, 20]. These patients, who are breathing and have intact brainstem reflexes, could be labeled as deceased under the higher-brain criterion given they lack the ability for body–mind integration and possession of "full moral standing" [26]. The question is then raised: how much irreversible loss of

neocortical function is sufficient to consider someone dead? Are patients with severe and irreversible dementia, who are still breathing and who still have a beating heart, but have profound cortical damage and lack the ability to integrate higher-brain function with the body and external environment, considered deceased? In much of the world today, the majority of cultures would have a difficult time considering these patients, who have long been labeled as alive, now deceased. Another significant concern is the ability to empirically measure or determine death. If death refers to the loss of higher consciousness and an individual's place in moral culture, or loss of personhood, how does one know and quantify when this occurrence takes place [28, 29]? Determinations of death based on loss of higher-brain definitions are therefore individualized and "person-oriented" and strictly non-biological; consequently, specific tests to fulfill this still need be described and validated [20, 28]. Otherwise, determining death becomes highly subjective.

7 Ensuring Certainty Compels the Whole-Brain Criterion

Brainstem and higher-brain formulations are individually important because they each reference critical functions of the human organism. Each, however, is insufficient to stand on its own in satisfying a reliably permanent and measurable definition of death, and therefore a whole-brain formulation is necessary (see Fig. 1). Both the brainstem and cortex are necessary to create the emergent property of consciousness, which is arguably the single feature that makes the brain *sui generis* among organs [16]. The brainstem formulation, while easier to measure with bedside exams, cannot offer guidance on when a radiographically intact cortex or function measured by electroencephalography is moot because such a bedside exam cannot predict when peri-insult edema will recede, or penumbra may recovery adequately to reinstitute reticular activating system function. Likewise, a neurologic insult sufficient to radiographically obliterate cortex but not cause sufficient elevation in intracranial pressure to obviate cranial nerve function or a respiratory drive is not reliably irreversible. This argument has led some to suggest that a determination of death by neurologic criteria should always include a measurement of brain circulation (angiogram, nuclear flow study, or transcranial

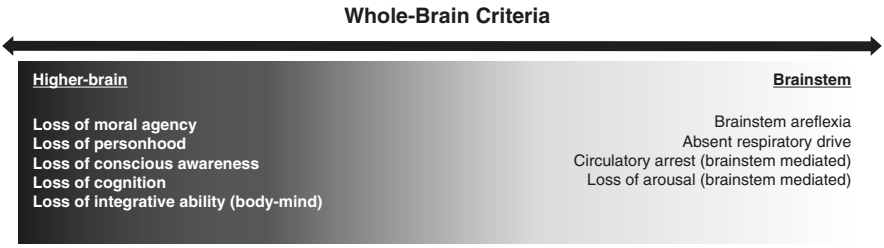

Fig. 1 Potential formulations of death by neurologic criteria

doppler) to demonstrate cerebrovascular arrest, and thereby corroborate that function will not return [30].

The whole-brain criterion offers a higher level of assurance that the damage to the brain is severe enough that function will not return. Requiring loss of all functions of the brain, as described in the whole-brain formulation, has been likened to the Talmudic principle of "building a fence around the Torah" where one assumes a conservative posture outside of an area of uncertainty to ensure that the law or truth is being respected [31]. Emerging science would suggest the growing importance of such reassurance. Investigation into disorders of consciousness have revealed with brain imaging, latent consciousness in severe neurologic injury to the extent that a patient may be able to experience the world in a way that cannot be detected by a clinician [32, 33]. As we cannot ensure what we cannot measure, dysfunction of the whole-brain provides a necessary reassurance that cannot be provided by either the brainstem or higher-brain criterion [34].

In a similar fashion, multiple studies have shown that patients declared dead by neurologic criteria do not always have loss of all cellular architecture [35, 36]. A recent study showed that restoration of brain circulation in a postmortem but intact pig brain allowed return of some cellular activity 4 h after circulatory–respiratory arrest [37]. While opponents would use these data to indicate that death by neurologic criteria is inaccurate and that brain function is still possible, proponents would argue that severe enough injury that leads to clinically indetectable neurologic activity demonstrates that not every cell needs to be lost for the brain to lose its ability to provide the functions necessary to support that the organism is living.

8 Conclusions

Clinicians offering a determination of death by neurologic criteria will inevitably be confronted with questions from patients such as "but why is their heart beating" and "why can the rest of the body be working if they are dead?" While an offering of legal categorization and hospital standard will often suffice, for many patient families, it will not be enough. The clinician themselves ought to establish in their own mind why such a state of being is morally and rationally equivalent to death by circulatory–respiratory criteria. While the brainstem and higher-brain formulations offer significant insight into essential functions of the brain, only the whole-brain criterion supports a valid claim of a transition from life to death in the case of catastrophic neurologic injury. Despite the claim of the minority dissent, the need for a rational argument and moral justification does not mean neurologic criteria is a construct—biology, and most importantly complex biologic organisms, deserve the respect of a thorough rational exploration that shows that life cannot be reduced to a single attribute in our current state of advanced organ supporting and replacing technology.

References

1. Report of the Ad Hoc Committee of the Harvard Medical School to Examine the Definition of Brain Death: a definition of irreversible coma. JAMA 1968;205(6):337–40.
2. President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research Defining Death: Medical, Legal, and Ethical Issues in the Determination of Death. https://repository.library.georgetown.edu/handle/10822/559345. Accessed 23 Feb 2022.
3. The Quality Standards Subcommittee of the American Academy of Neurology. Practice parameters for determining brain death in adults. Neurology. 1995;45(5):1012.
4. Wijdicks EF, Varelas PN, Gronseth GS, Greer DM. Evidence-based guideline update: determining brain death in adults: report of the Quality Standards Subcommittee of the American Academy of Neurology. Neurology. 2010;74(23):1911–8.
5. Truog RD, Miller FG. The meaning of brain death: a different view. JAMA Intern Med. 2014;174(8):1215–6.
6. Joffe AR, Anton NR, Duff JP, Decaen A. A survey of American neurologists about brain death: understanding the conceptual basis and diagnostic tests for brain death. Ann Intensive Care. 2012;2(1):4.
7. Siminoff LA, Burant C, Younger SJ. Death and organ procurement: public beliefs and attitudes. Soc Sci Med. 2004;59(11):2325–34.
8. Lewis A, Bakkar A, Kreiger-Benson E, Kumpfbeck A, Liebman J, Shemie SD, et al. Determination of death by neurologic criteria around the world. Neurology. 2020;95(3):e299–309.
9. Bernat JL. How the distinction between "irreversible" and "permanent" illuminates circulatory-respiratory death determination. J Med Philos. 2010;35(3):242–55.
10. Bernat JL. Controversies in defining and determining death in critical care. Nat Rev Neurol. 2013;9(3):164–73.
11. Bernat JL. Are organ donors after cardiac death really dead? J Clin Ethics. 2006;17(2):122–32.
12. Macklem PT. Emergent phenomena and the secrets of life. J Appl Physiol. 2008;104(6):1844–6.
13. Macklem PT, Seely A. Towards a definition of life. Perspect Biol Med. 2010;53(3):330–40.
14. Bernat JL. Refinements in the 0rganism as a whole rationale for brain death. Linacre Q. 2019;86(4):347–58.
15. Bonelli RM, Prat EH, Bonelli J. Philosophical considerations on brain death and the concept of the organism as a whole. Psychiatr Danub. 2009;21(1):3–8.
16. Huang AP, Bernat JL. The organism as a whole in an analysis of death. J Med Philos. 2019;44(6):712–31.
17. Bernat JL. A conceptual justification for brain death. Hast Cent Rep. 2018;48(Suppl 4):S19–s21.
18. Crane JK. Biological-mereological coincidence. Philos Stud. 2012;161(2):309–25.
19. Bernat JL, Culver CM, Gert B. On the definition and criterion of death. Ann Intern Med. 1981;94(3):389–94.
20. Bernat JL. The biophilosophical basis of whole-brain death. Soc Philos Policy. 2002;19(2):324–42.
21. Shewmon, DA. Statement in support of revising the Uniform Determination of Death Act and in opposition to a proposed revision. J Med Philos. 2021. Online ahead of print.
22. Simpson P, Bates D, Bonner S, Costeloe K, Doyal L, Falvey S, et al. A code of practice for the diagnosis and confirmation of death. Academy of Medical Royal Colleges. https://aomrc.org.uk/wp-content/uploads/2016/04/Code_Practice_Confirmation_Diagnosis_Death_1008-4.pdf. Accessed 24 Feb 2022.
23. Pallis C. ABC of brain stem death. Reappraising death. Br Med J (Clin Res Ed). 1982;285(6352):1409–12.
24. Veatch RM. The impending collapse of the whole-brain definition of death. Hast Cent Rep. 1993;23(4):18–24.

25. Veatch RM. Would a reasonable person now accept the 1968 Harvard brain death report? A short history of brain death. Hast Cent Rep. 2018;48(Suppl 4):S6–s9.
26. Eberl JT. A Thomistic defense of whole-brain death. Linacre Q. 2015;82(3):235–50.
27. Veatch RM. The death of whole-brain death: the plague of the disaggregators, somaticists, and mentalists. J Med Philos. 2005;30(4):353–78.
28. Khushf G. A matter of respect: a defense of the dead donor rule and of a "whole-brain" criterion for determination of death. J Med Philos. 2010;35(3):330–64.
29. Green MB, Wikler D. Brain death and personal identity. Philos Public Aff. 1980;9(2):105–33.
30. Dalle Ave AL, Bernat JL. Inconsistencies between the criterion and tests for brain death. J Intensive Care Med. 2018;35(8):772–80.
31. Gelb DJ. Building a fence around brain death: the shielded-brain formulation. Neurology. 2021;97(16):780–4.
32. Edlow BL, Chatelle C, Spencer CA, et al. Early detection of consciousness in patients with acute severe traumatic brain injury. Brain. 2017;140(9):2399–414.
33. Schiff ND. Cognitive motor dissociation following severe brain injuries. JAMA Neurol. 2015;72(12):1413–5.
34. Verheijde JL, Rady MY, Potts M. Neuroscience and brain death controversies: the elephant in the room. J Relig Health. 2018;57(5):1745–63.
35. Walker AE, Diamond EL, Moseley J. The neuropathological findings in irreversible coma: a critique of the "respirator brain". J Neuropathol Exp Neurol. 1975;34(4):295–323.
36. Wijdicks EF, Pfeifer EA. Neuropathology of brain death in the modern transplant era. Neurology. 2008;70(15):1234–7.
37. Vrselja Z, Daniele SG, Silbereis J, et al. Restoration of brain circulation and cellular functions hours post-mortem. Nature. 2019;568(7752):336–43.