Brain Death: An Investigation of Current Controversies

Meile Moore
mmm255@zips.uakron.edu

Please take a moment to share how this work helps you through this survey. Your feedback will be important as we plan further development of our repository.

Follow this and additional works at: http://ideaexchange.uakron.edu/honors_research_projects

Part of the Bioethics and Medical Ethics Commons, and the Diagnosis Commons

Recommended Citation

This Honors Research Project is brought to you for free and open access by The Dr. Gary B. and Pamela S. Williams Honors College at IdeaExchange@UAkron, the institutional repository of The University of Akron in Akron, Ohio, USA. It has been accepted for inclusion in Honors Research Projects by an authorized administrator of IdeaExchange@UAkron. For more information, please contact mjon@uakron.edu, uapress@uakron.edu.
Brain Death: An Investigation of Current Controversies

Meile M. Moore

The University of Akron
Abstract

Brain death is a highly debated and controversial topic spanning across several bodies of knowledge. Controversies of brain death include, but are not limited to, lack of consensus, false-positive diagnoses, residual function, public perception, and rights. Though brain death is often sensationalized by the media, distrust by the general population is warranted. The lack of consensus amongst professionals regarding brain death suggest that the American Academy of Neurology’s criterion must be revised. At the minimum, revising of the AAN criterion should focus on evolving ancillary testing, and establishing a minimum observation time before declaring death. Upon further clarification of discrepancies, trust will be restored in the medical community regarding end of life decisions.

Keywords: brain death, history, criteria, diagnosis, false-positives, public perception, rights, organ donation, controversies, ancillary testing
The History of Brain Death

For up until the middle of the 20th century, death was defined by the irreversible cessation of circulation and respiration (De Georgia, 2014, p. 673). However, the emergence of clinical technology would establish a new understanding of the end of life--brain death (BD). The ideology surrounding the inception of the term “brain death” can be traced back as far as 300 B.C., beginning with a reflection of the connection of the soul, or mind, to the nervous system. One of the first descriptions of this relationship is linked to Herophilus of Chalcedon (Wijdicks, 2017, p. 1). At around 300 B.C., his anatomical observations were the first to describe nerves, and he hypothesized their ability to induce sensation or manipulate movement (Bay & Bay, 2010, p. 281). Galen, around 160 A.D., had also inferred the brain’s connection to the mind, delineating the cranial nerves, and observing deficits in perception as a result of brain injury (Wijdicks, 2017, p. 1). Despite such early speculations, the movement towards a new definition was not incepted until the middle of the 20th century.

The introduction of the mechanical ventilator served as the dawn towards describing BD with the emergence of the persisting, irreversible comatose patient (Wijdicks, 2017, p. 2). This state of coma consisted of lack of brainstem function, excessive urine production, decrease in vascular size, absence of electroencephalographic (EEG) activity, and profound neural destruction uncovered during autopsy (Wijdicks, 2017, p. 2). In 1954, Robert Schwab, upon analysis of a comatose patient suffering from massive brain damage, became the first to describe a death despite the presence of active circulation. Patients were described as only being temporarily maintained, as they would inevitably die from cardiac arrest. A similar conclusion was also drawn out by French neurologists Wertheimer, Jouvet, and Descotes in their 1959 report *Diagnosis of death of the nervous system in comas with respiratory arrest treated by*
artificial respiration (Wijdicks, 2017, p. 2). The absence of EEG activity, brain stem reflexes, and respiration were consistent finding, thus formulating the term “death of the nervous system”. However, another group of French neurologists, Mollaret and Goulon, were unsure of referring to this condition as a death equivalent. Due to the high degree of uncertainty regarding whether such criteria could establish a new definition of death, they preferred the term “beyond coma” (De Georgia, 2014, p. 673). Regardless, Schwab disagreed with the notion, believing that EEG technology and standardization of the appropriate criteria could provide assurance of the new death equivalent (De Georgia, 2014, p. 673-674).

In 1963, Schwab introduced the criteria triad for BD determination. The criteria included: unresponsive, dilated pupils with a lack of evocable reflexes, a flat EEG, and absence of spontaneous respiration (apnea). Schwab stated that patients who met the three criteria, despite functioning circulation, could be declared dead. Such criteria were based on his findings amongst 90 patients, whom all had profound neural necrosis at autopsy (De Georgia, 2014, p. 674). To finalize and formally establish the new definition of death, an Ad Hoc Committee at Harvard University was formed. In 1968, based on Schwab’s triad, the committee had formulated four criteria: unresponsiveness to stimuli, lack of movement and respiration, lack of reflexes, and a flat EEG. Though a flat EEG was determined to be a component in determining BD, as it would reflect the underlying brain necrosis found at autopsy, many argued against it in favor of the brain stem’s role in consciousness (De Georgia, 2014, p. 675). The Ad Hoc committee, nonetheless, struggled with equating BD to death. Initially, they stated that the BD patient would be “essentially dead”, as the condition would eventually lead to death via cardiac arrest (De Georgia, 2014, p. 675). Schwab, despite developing the triad of BD criterion, was also reluctant. He had begun to align more with Mollaret and Goulon, believing that the irreversible coma was
not equal to death, only representing a prognosis of it. In the end, the Ad Hoc committee decided to align with a more cautionary position, and developed the “A Definition of Irreversible Coma” to serve as a practical, and ethical guidance for physicians (De Georgia, 2014, p. 675).

Despite the Ad Hoc committee’s cautionary position, the definition of the irreversible coma as BD was met with skepticism and concern. Many believed the article had a utilitarian tone, with motives to establish BD as a means of increasing the numbers of hospital beds, or with benefitting organ transplantation (De Georgia, 2014, p. 675). Tension surrounding organ donation and BD was plausible, as transplantation efforts were occurring concurrently (Machado, et al., 2007). However, separation was difficult, if not impossible. Even Joseph Murray, a pioneer of transplantation and member of the Ad Hoc committee, noted that BD was not created to benefit organ donation, but at the same time potential organs were being wasted (De Georgia, 2014, p. 675). Nonetheless, in the 1970s, BD started to become recognized as new death equivalent, though varying in criterion across the United States. Some states had eliminated the need for an isoelectric EEG by reaffirming importance of the brain stem instead. This notion was also established in much of the UK (De Georgia, 2014, p. 676).

The legal recognition of BD as equivalent to death across the states created the need for uniformity in the country. The President’s Commission was convened in 1979 to establish a uniform, and concise definition of death to include BD. The Commission was heavily inspired by James Bernat’s On the Definition of Death and Criterion of Death (De Georgia, 2014, p. 676). Bernat’s ideology of death was defined as “the permanent cessation of functioning of the organism as a whole” (Bernat, et al., 1981). Coinciding this, Bernat had developed the “whole brain criterion”, given that function of the brain, including the brainstem, was critical for the survival of the organism (Bernat, et al., 1981). Relating to Bernat’s whole brain criterion, the
Commission established the brain as the master regulator of all bodily function, whose absence would inevitably result in body’s inability to maintain itself, as characteristic of death. This statement by the Commission would result in the Uniform Declaration of Death Act (UDDA) of 1981, formally finalizing BD as a new death equivalent (De Georgia, 2014, p. 676).

**Determining Brain Death**

**The Current Definition and Criteria**

The current definition of BD, as established in the UDDA in 1981 is as follows: “irreversible cessation of all functions of the entire brain, including the brain stem” (Sade, 2011, p. 1-2). By including BD into the UDDA, the term became equated to the traditional view of cardiac death, which would suggest the brain to promote critical, integrative functions of the entire body (De Georgia, 2014). In the *Evidence-based guideline update: Determining brain death in adults Report of the Quality Standards Subcommittee of the American Academy of Neurology*, BD is currently characterized by irreversible coma, lack of brain stem reflexes, and apnea (Wijdicks, et al., 2010, p. 1914).

Despite advancements in clinical technology, there have been very little changes in criteria for BD as established by the American Academy of Neurology (AAN) in 1995. There is currently no standardized, minimal neurological observation period required to ensure permanent loss of function. In addition, ancillary tests like magnetic resonance imaging (MRI), magnetic resonance angiography (MRA), CT angiography (CTA), and somatosensory evoked potentials (SSEPs), have not been proven to be statistically significant in the diagnosis of BD (Wijdicks, et al., 2010, p. 1913-1914). As such, the AAN follows a “practical, non-evidence” based method in
establishing a diagnosis. Determination follows four steps: clinical evaluation, neurological assessment, ancillary tests, and documentation of the BD (Wijdicks, et al., 2010, p. 1914).

I. Clinical Evaluation

Clinical evaluation begins with establishment and determination of the coma. Following coma analysis, any drugs remaining in the patient must be metabolized, including depressants of the nervous system and neuromuscular blockers. Any abnormal presence of electrolytes or hormonal imbalance should also be ruled out. A normal, core body temperature is then established usually with a warming blanket. Core temperature should be maintained above, or near, 36°C (Wijdicks, et al., 2010, p. 1914). Maintaining a normal, core body temperature prevents delayed rising of PaCO₂, ensuring optimal conditions for the eventual apnea test. Upon reaching the optimal body temperature, normal systolic blood pressure above, or equal to 100 mm Hg is achieved (Wijdicks, et al., 2010, p. 1915).

II. Neurological Assessment

Optimal, bodily conditions permit the neurologic examination portion of the clinical evaluation. Currently, only one neurological examination is needed (and is deemed sufficient in the majority of the United States). There are some states, however, that require at least two neurological evaluations. Several hours must be allowed to pass before the neurological evaluation. All physicians, regardless of specialty and expertise, are permitted to establish BD; however, they must be competent, and versed in the corresponding criteria before diagnosis. During the neurological assessment, the comatose patient must lack responsiveness to noxious stimuli, including demonstrating a total lack of eye movement and motor reflexes (other than those mediated by the spine). The lack of brainstem reflexes is especially critical, and assessed
via the absence of pupillary, ocular, oculovestibular, corneal, facial muscle, pharyngeal, and tracheal reflexes (Wijdicks, et al., 2010, p. 1915).

The pupillary response is assessed by shining a bright light into the eyes, and determining dilation of the pupils. Constriction of pupils in response to light is indicative of brain stem function, or the presence of drugs. The presence of ocular reflexes, under the pretense of an intact cervical spine, are assessed by rotating the head. Eye movement should not occur in relation to head rotation. Oculovestibular reflexes are assessed by irrigating 50 mL of ice water into the ear canal. Ocular movements are observed for one minute, and should not be seen on both sides. The corneal reflex is determined by swabbing the eye with a piece of cotton, tissue paper, or by squirting with water; no eyelid movement should occur. To assess facial muscle reflexes, deep pressure is applied to the condyles of the temporomandibular joint and the supraorbital ridge. Facial muscle movement, in any capacity, should not be observed. The responses of the pharynx and trachea, the final set of brainstem reflexes, are conducted simultaneously. A suction device, or tongue blade, stimulates the posterior of the pharynx. The absence of a gag reflex and cough determines the lack of the pharyngeal and tracheal response respectively (Wijdicks, et al., 2010, p. 1915). The absence of all brainstem reflexes permits the final portion of the neurological assessment: the apnea test.

The apnea test is the final component in determining total loss of brainstem function, that is, to prove the absence of respiration without artificial support (Scott, et al., 2013, p. 533). Before conducting the apnea test, the patient must exhibit sufficient blood concentration, optimal PaCO₂ levels of 35-45 mm Hg, lack of hypoxia, absence of CO₂ retention, normal blood pressure and core body temperature (Wijdicks, et al., 2010, p. 1915). Upon determining optimal bodily conditions, vasopressors are set to the systolic blood pressure (100 mm Hg). Oxygenation of
100% O₂ with PaO₂ above 200 mm Hg is maintained for 10 minutes, after which ventilation frequency is diminished to 10 breaths per minute. Baseline blood gas is recorded if the O₂ is above 95%. The ventilator is subsequently disconnected, upon which signs of respiration are observed. Notable signs of respiration include abdominal risings, or gasps of air. The arterial blood gas is then measured after approximately 8-10 minutes. If pCO₂ is ≥ 60 mm Hg (or 20 mm Hg higher than the initial baseline recording), and no indications of respiration are observed, the apnea test confirms the diagnosis of BD. The apnea test is considered negative, or inconclusive, if any of the following occur: systolic blood pressure decreases to below 90 mm Hg, oxygen saturation is above 85% for more than 30 seconds, and spontaneous respiration (Wijdicks, et al., 2010, p. 1915-1916). If proven inconclusive and the patient has a stable blood circulation, the test can be repeated. Otherwise, ancillary tests are generally used to confirm the BD diagnosis (Wijdicks, et al., 2010, p. 1916).

III. Ancillary Tests

Ancillary tests are generally used, at the discretion of the physician, when uncertainty exists regarding the state of BD. The AAN states that use of such tests are unneeded when diagnosing adult patients, and cannot substitute the neurological assessment. In the event ancillary tests are used, the AAN recommends an expert opinion. Ancillary tests of choice include: EEG, cerebral angiography, MRI, MRA, nuclear scans, transcranial doppler (TCD), and CTA. MRI, MRA, and CTA are not found to be statistically significant in BD diagnosis; utmost caution must be used in the event of false-positives (Wijdicks, et al., 2010, p. 1916).

IV. Documentation of Brain Death

Upon confirmation, the time of death is recorded. The time of death is established the moment arterial PCO₂ is at the appropriate level with a positive apnea test. The time of death is
otherwise noted upon confirmation with an ancillary examination. Retrieval of organs occurs promptly after declaration of death, provided that the deceased, or respective representatives, have given approval (Wijdicks, et al., 2010, p. 1916-1917).

**Controversies of Brain Death Diagnosis**

**Lack of Brain Death Consensus**

Despite the release of the *Evidence-based guideline update*, which sought to unify the BD determination across all institutions, protocol for diagnosis differs significantly across the United States. In the 2016 investigation *Variability of Brain Death Policies in the United States*, which surveyed 492 hospitals across the 50 states, it was found that not all had adopted the guidelines as proposed by the AAN. The AAN states that no neurological expertise is required for BD diagnosis, however the physician should be well versed in the respective criteria. Despite this, 33.1% of the sampled institutions required neurological expertise for BD determination (Greer, et al., 2016, p. 214). In addition, 43.1% also specifically require an attending physician for the examination, regardless if that physician is versed in neurology. Interestingly, there are eight institutions that allow more junior physicians, or other medical professionals, to conduct the clinical examination. The AAN also states that only one clinical examination is needed for BD determination. However, the majority (65.9%) require two separate examinations and only 13.0% mandate one examination. Hospitals that require two examinations generally mandate that they must be conducted by different physicians. There are also varying lengths of waiting periods required when multiple examinations are needed. Most hospitals require at least six hours (71.1%), while the vast minority stipulate 24 hours (1.1%). Waiting periods, generally for 24 hours, are also mandated in the event of cardiac arrest, though only in 7.1% of hospitals.
Long waiting periods, in general, are suggested to negatively impact organ donation (Greer, et al., 2016, p. 217). The prerequisites for the clinical examination also differ significantly. The majority follow the AAN guidelines, with 82.9% require establishing the cause of coma, and 73.9% require the complete absence of all medications including sedatives and paralytics. The majority (73.9%) also require the absence of any possible confounding conditions, yet of these policies, only 71.1% mandate the additional absence of endocrine disorders (Greer, et al., 2016, p. 215). It is alarming that a significant percentage do not follow the AAN prerequisites, indicating a higher likelihood for error for such institutions. Pertaining to the clinical examination, nearly all (97.4%) policies require apnea testing, yet the functional analysis of the brain stem differs significantly. For example, though nearly all (92.9%) require the lack of pupillary responses, only 28.7% examine constriction of the pupils. In addition, a significant minority (22.6%) examine the “jaw jerk reflex” (Greer, et al., 2016, p. 215).

Following clinical examination, 6.5% of the institutions require ancillary testing. For all institutions, when ancillary testing is used, the majority (78.8%) utilize the EEG. Evoked potentials are also still mandated in 26.1%, CTA in 9.0%, and MRA in 2.9%, all of which are not endorsed by the AAN (Greer, et al., 2016, p. 216-217). The minority of hospitals that do not follow the AAN recommendations, especially for expertise in BD criterion, fulfillment of prerequisites, thorough analysis of brain stem function, and utilization of invalidated ancillary tests, are of a significant concern.

Though the AAN describes neurologists as having utmost expertise in determining a BD diagnosis, consensus amongst such professionals also varies widely. Interestingly, in a survey of 192 neurologists in the United States, when asked to give a conceptual justification for equating BD as death, 50% of respondents referred to the loss of higher brain function itself, while only
29% actually justified it as the irreversible loss of integration of bodily functions by the brain” (Joffe, et al., 2012, p. 4). Referring to BD as equivalent to death due to the loss of higher brain function reflects a significant conflict with the AAN standard. It should also be noted that the vegetative state could also be justified with such a response. Perhaps more startling, when explicitly asked if BD was the same as cardiac death, the majority (54%) responded “no” (Joffe, et al., 2012, p. 4). This survey demonstrates that even neurologists themselves, despite being considered experts in BD, express uncertainty about the criteria, and cannot provide ample justification in equating it to death.

This lack of uniformity is not limited to the United States. There is a notable lack of BD consensus globally, varying in both sociocultural perceptions, as well as diagnosis protocol. In a worldwide survey of 94 countries, 57% of respondents do not equate BD with cardiac death (Wahlster, et al., 2015, p. 1872). The use of mandated ancillary testing is also relatively frequent (29% of all countries surveyed). Interestingly, in conflict with the AAN, the majority (56%) consider activity derived from ancillary testing to be incompatible with a positive clinical examination, refuting a claim of BD (Wahlster, et al., 2015, p. 1875).

**False-Positive Diagnoses and Residual Function**

Despite movements to increase uniformity in BD diagnosis by the AAN, false-positive claims, as well as depictions of reversibility, are still current. In contrast, the AAN states that there are currently no documented cases of BD false-positives and reversibility, with any cases suggesting such claims determined to be confounded (Wijdicks, et al., 2010, p. 1911). One such case, though confounded by the AAN, had presented “reversible BD” as a possibility when faced with induced hypothermia and cardiopulmonary arrest (Webb & Samuels, 2011). The case report details a 55-year-old man experiencing respiratory failure who was placed into an intensive care
unit following cardiopulmonary resuscitation. Within the first hour, the patient became comatose, with noncontrast head tomography scans revealing swelling, effacement, and indistinct white and gray matter junctions (Webb & Samuels, 2011, p. 1538). To prevent brain herniation, at hour 16, the patient was subjected to induced hypothermia. However, at hour 56, the patient had lost nearly all brain stem function and had minimal EEG activity. At hours 72 and 78, two clinical examinations following the AAN guideline were administered by separate neurologists. Both clinical examinations and the following apnea test were consistent with BD criterion, allowing pronouncement of death. However, at hour 98 the patient had regained the cough reflex, corneal reflex, and spontaneous respiration (Webb & Samuels, 2011, p. 1539). The BD diagnosis and determination of death were revoked. Nonetheless, the patient suffered from a profound brain trauma that resulted in the subsequent absence of cerebral blood flow, resulting in death (Webb & Samuels, 2011, p. 1540). The case report mentioned urges caution in diagnosing following hypothermia and cardiopulmonary arrest. This warning is significant as Webb and Samuels had also mentioned that nearly 25% of all organ donors constitute individuals diagnosed as brain dead following cardiac arrest (Webb & Samuels, 2011, p. 1541). However, despite their claims, it is highly unlikely that this case depicts an actual “reversible BD” scenario. Rather, it is far more likely to reflect a false-positive diagnosis, but, regardless, casts significant doubt on whether the recommended AAN criterion is sufficient enough to diagnose BD in all scenarios.

False-positive claims are also depicted in “BD mimic” cases. Currently, the AAN describes several “mimic” cases that fulfill the criteria for BD. The cases depict conditions such as “Guillain-Barré syndrome (GBS), organophosphate intoxication, high cervical spinal cord injury, lidocaine toxicity, baclofen overdose, and delayed vecuronium clearance” that could present challenges in establishing a BD diagnosis. However, such cases were determined to be
relatively insignificant, as such studies suggesting mimicry had not completely followed the AAN guideline (Wijdicks, et al., 2010, p. 1912). However, such cases were determined to be insignificant as they had not followed the guideline recommended by the AAN. Nonetheless, six years after the release of the *Evidence Based Guideline Update*, another BD mimic case of GBS was reported. GBS is described as set of chronic, autoimmune disorders resulting in degeneration of the peripheral nervous system, particularly nerves innervated with muscles (Niemi, 2013). Interestingly, it is also the only disorder currently stated by the AAN to fulfill BD criteria. In a 2016 case report, a 60-year-old man suffering from acute motor axonal neuropathy, a form of GBS, fulfilled the clinical criteria for BD, including lack of brainstem function and a positive apnea test. However, the patient had not suffered from any form of severe brain trauma, provoking uncertainty despite a positive clinical assessment implicating BD. The physicians conducted an EEG analysis, and discovered significant cortical activity, disproving the results of the clinical BD assessment (Ravikumar, et al., 2016). The patient had survived the GBS incident, recovering consciousness and significant function over time (Ravikumar, et al., 2016).

Unnervingly, had the physicians strictly followed the guidelines set by the AAN, the patient would have been misdiagnosed as brain dead.

Although BD is supposed to reflect the total loss of integrative bodily function by the brain, residual functions remain even after diagnosis. Even those diagnosed with BD can exhibit neuroendocrine homeostasis, maturation, immune responses, support gestation of a fetus, and respond to bodily harm (Nair-Collins, 2017, p. 526). The sheer number of residual functions is problematic, and casts significant doubt onto what is considered a critical function for maintaining integrity of the organism. It is then likely that the criterion established by the AAN are not sufficient, and may not be applicable in every BD scenario.
Public Perception and Rights

The concept of BD is poorly understood by the general population. The media tends to sensationalize BD scenarios, and internet sources that laymen tend to gravitate to are not credible, both of which do not aid in the public’s education of the matter. Misinformation regarding the state of BD only create further animosity towards the medical community regarding end of life decisions. In an investigation of internet sources like Google and YouTube, nearly 40% of top websites described BD inaccurately while also referencing organ donation 90% of the time (Jones, et al., 2018, p. 3). Pertaining to YouTube, the majority 60% also promoted inaccurate BD statements, and often used the terms “vegetative state” and “coma” interchangeably (Jones, et al., 2018, p. 4). In such videos, negative tones were the most prevalent, with only hostility expressed towards organ donation and physicians (Jones, et al., 2018, p. 5). It is clear that the general public, perhaps as a result of being misinformed, are wary and distrustful of the medical community regarding BD.

Pertaining to organ donation, it is a common misconception amongst the general population that establishment of the BD diagnosis was put in place to benefit live organ donation. As stated earlier, successful organ transplantation and the establishment of BD was occurring in parallel. Nonetheless, despite their independent realizations, organ donation and BD cannot realistically be viewed as separate entities, neither in legislature, net or in the public view (Machado, et al., 2007). Even members of the Ad Hoc Committee, the first to formally establish BD criterion, believed that organ donation from such patients could be beneficial (Verheijde, et al., 2009). Today, the majority of organ donation arises from procurement from BD patients (Nair-Collins, 2017, p. 526). Organ removal itself is deemed impermissible if it results in the death of the individual, as stated by the Dead Donor Rule (DDR). However, given that the
establishment of the UDDA allowed accordance with the DDR, organ removal from BD patients is deemed permissible (Nair-Collins, 2017, p. 526). However, not all agree with this legality, believing organ donation to be a violation of moral status. The residual, homeostasis maintaining functions could suggest the organism to at least be “biologically” alive (Nair-Collins, 2017). If that is the case, removing organs without explicit consent would infringe upon moral status, destroy the biological integrity of the organism, causing death, and would violate the DDR.

Regarding rights, it is important to consider the representatives, often familial, of BD patients, whom ultimately determine the end of life decisions. In some states, consideration for such representatives is becoming lost in favor of establishing more uniform BD policies. In 2017, the Nevada Supreme Court had determined that informed consent is not required to make a BD diagnosis—particularly in conducting the apnea test (Assembly Bill, 2017). In this manner, BD diagnosis by the AAN becomes equivalent to “irreversible cessation of circulatory and respiratory function” which does not require consent to establish death of the patient (Assembly Bill, 2017). This undermining of the BD patient’s representatives may only heighten the existing distrust from the general population. It should be noted that death is not limited to biological viewpoints, and encompasses a variety of religious perspectives. Not all religions accept BD, and believe the absence of circulation to establish death (Robert & Robert, 2017). The apnea test, and corresponding brain stem functional analysis, may also be considered invasive. Even when there is a declaration of death, invasive procedures still require consent of familial representatives (Mohamed, et al., 2017). However, there is a minority of states that do accommodate for opposing views of BD. California, Illinois, New Jersey, and New York are the only states that allow families to refute BD as death on religious grounds (Nelson, 2017, p. 499).
Discussion

Although BD was originally formulated to resolve the dilemma of the irreversible, comatose patient, its creation has resulted in an increasing number of ethical, legal, and medical conflicts. The varying, and numerous controversies suggest that there is still much uncertainty whether the irreversible loss of the critical functions of the brain, including the brainstem, can be accurately determined by the AAN guidelines. BD is also still a relatively new term, having only been formally established in 1968, and enacted nationally for around 37 years since the introduction of the UDDA. Though the field of neuroscience and ancillary tests continue to evolve, implementation into BD criterion has been stagnate. Given that the AAN criterion only rely on practical, indirect assessments of brain function, further research in ancillary testing is critically needed to clarify any discrepancies. Widespread brain trauma outside of the brain stem can only be assessed via ancillary testing like the EEG. Given this, ancillary examinations using validated measures could serve as a preventative measure, and should be reconsidered as a critical component to the clinical examination. Nonetheless, at the least, uniformity in the pre-clinical examination, and a more standardized, minimal observation period are needed. Though the majority of institutions follow the AAN prerequisites, it is alarming that a significant portion do not make efforts to eliminate any, and all, confounding factors. A standardized observation period should also be considered to eliminate any chance of recovery, and give sufficient time for familial representatives to establish end of life decisions. Though longer waiting periods may negatively impact organ donation, it is important to note that harvesting of such would be unethical if the patient had any hope of recovery. Up until the patient is officially documented as dead, the individual still retains moral status, and is deserving of equal treatment that any other
patient could be afforded. Physicians must be wary of their own disposition, as utilitarian motives may only build distrust in the families of BD patients.

Uneasiness of the general population regarding BD is valid when considering that there is still no professional consensus, and that acceptance of such may require reworking of sociocultural norms. It may be unreasonable to expect laymen to simply equate BD to the traditional model of death given the current state. Nonetheless, it is the duty of the medical community to reaffirm confidence within the general population. Thus, physicians must strive to eliminate any margin of error, as any false-positive diagnoses will result in irreversible, fatal consequences. In doing so, trust of the general population will be restored in the medical community regarding end of life decisions.

**Limitations**

The controversies of BD are incredibly wide, and this review barely encompasses the sheer breadth of corresponding topics. The overview of literature only presents controversies of BD determination for adults. BD diagnosis in children differs, and has been omitted from this study. This study simply seeks to present a sample of BD topics in philosophical, legal, and medical realms.
References


doi:10.1097/CCM.0b013e3182186687
