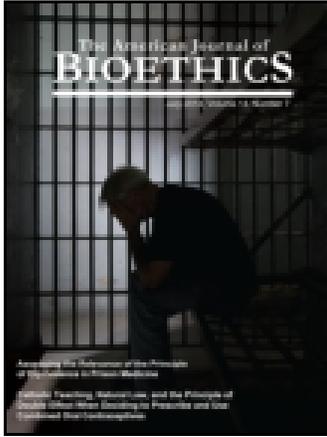


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Toward a Science of Brain Death

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not correspond to biological reality. One wonders how this is supposed to work.

Imagine that you are a physician working in a critical care unit. Suppose you have been caring for a patient who you are now quite certain is brain dead and you think that the patient is a good candidate to be an organ donor. When you tell the family of the brain-dead patient that their loved one is legally dead, what else do you tell them? If you don't explain that their loved one is not really dead at all, then you are deceiving them, for, of course, they will suppose that he is. If you do explain that their loved one whom you have just pronounced legally dead is not really dead at all and, of course, why you are engaging in this apparent charade at an emotionally wrenching moment, then they will think you are engaging in obfuscation in order to snatch their loved one's organs. These consequences of the Miller–Truog view are quite unattractive.

The Miller–Truog view that the determination of death in the case of brain-dead potential organ donors should be understood as a legal fiction *in their sense* has no merit that I can see at all. When a knowledgeable physician says that

a brain-dead potential organ donor is legally dead and does not engage in a convoluted explanation of what that means, the physician is engaged in deceit. It's just that simple. ■

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Toward a Science of Brain Death

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Let's begin with what we know: One way or another, we all die. What we don't know precisely is *when* death occurs. Yet however inaccurate our definition of death may be, it plays an instrumental role in medical practice. We also know that the responsible scientist is willing to admit that she does not fully understand a phenomenon still under investigation. This is particularly true when she is confronted by counterexamples to well-founded scientific models. Reflection on model construction highlights the balancing act that takes place when investigators face unanticipated results. Either the results must be rejected or the model must be altered to account for novel findings. In either event, and contrary to speculation, our understanding of the natural world is well served by the rigorous application of empirical methods.

In this issue of *American Journal of Bioethics*, Truog and Miller (2014) have attempted to resolve a puzzle that plagues scholarly reflection on brain death: What exactly is it and how does it relate to other medical concepts? They

contend that brain death does not correlate precisely with our current biological model of death. It follows, they argue, that we should drive a wedge between death as an empirically tractable phenomenon and brain death as an ethico-legal concept. While controversies surrounding brain death are indeed important touchstones for philosophical reflection, it remains unclear whether Truog and Miller's account is consistent with scientific intuition.

More than two decades ago, Veatch (1993; 1988) offered a structurally similar criticism of whole-brain death. Brain death, Veatch observed, "is ambiguous because it fails to distinguish between the biological claim that the brain is dead and the social/legal/moral claim that the individual as a whole is dead" (Veatch 1993, 18). In response, Veatch proposed a fine-grained neo-cortical model of death, which stipulated that those who had irreversibly lost certain higher order cognitive functions, including consciousness, ought to be considered dead. Importantly, this novel view has inspired reflection on

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what we, as a society, believe are sufficient conditions for the ascription of personhood to patients at the end of life.

In the intervening decades, however, Veatch's model has been undermined by scientific work on patients diagnosed with disorders of consciousness. Work by our group—and others—has demonstrated that some patients diagnosed as being in the vegetative state may retain preserved awareness undetectable through conventional bedside examination (Cruse et al. 2012; Owen et al. 2006). Moreover, some patients who satisfy the time intervals required for classification of the persistent vegetative state have even been able to communicate with the aid of neuroimaging (Fernández-Espejo and Owen 2013; Naci and Owen 2013; Monti et al. 2010). According to Veatch's neo-cortical account, such patients would be diagnosed as dead. However, our research on seriously brain-injured patients has shown that this conclusion is incorrect. It was not philosophical reflection on the concept of brain death that demonstrated this. Rather, careful science undermined Veatch's key assumption that it was possible to reliably identify *permanently* vegetative patients.

We observe, therefore, that science plays a vital role in constraining the normative articulation of medical concepts. Truog and Miller's argument, on the other hand, contradicts this empirical intuition. They propose a change in scholarly discourse that effectively turns its back on scientific practice. Rather than coming to terms with the ambiguities inherent in the definition of brain death, which may direct us to *empirical* questions in need of future research, Truog and Miller instead reconceptualize brain death as a "legal fiction." This approach, we believe, threatens to hand over the formulation of diagnostic categories to a priori analysis. In our view, what is needed is careful reflection on brain death that acknowledges its clear social impact but, ultimately, is grounded in rigorous empirical inquiry.

Undoubtedly, as Truog and Miller themselves note, the subtext of this debate is organ donation. Diagnosing death earlier in the dying process would allow organs to be procured before they begin to break down. Indeed, as Truog, Miller, and Halpern (2013) have observed elsewhere, families seeking meaning in the face of a loved one's untimely death may find great comfort in knowing that their misfortune will benefit others. Notwithstanding these benefits, the view that brain death is nothing more than a legal fiction may transform the diagnosis of death into a simple line drawing exercise. It is well known that prognostication of acutely comatose patients is extraordinarily difficult and subject to error. Thus, defining brain death as a legal fiction may bias clinical decision making in favor of organ procurement. Without scientific oversight, this may put historically vulnerable patients at greater risk. As demand for transplantation increases, so too will pressure to count more individuals as dead—and sooner—regardless of clinical safeguards.

How, then, can we account for ambiguities in the definition of brain death while simultaneously resisting the urge to reconceptualize it merely as a legal fiction?

Contrary to Truog and Miller, we believe an empirically rigorous definition of brain death that couples ethico-legal concepts with our most advanced scientific models is the most appropriate way forward. Simply put, this approach calls for *more* scientific data.

There is currently a dearth of empirical research on the neurophysiological processes that accompany the dying process. While electroencephalography (EEG), bispectral index (BIS), and somatosensory evoked potentials (SSEPs) have been used as ancillary tests to confirm that brain death has occurred, we do not currently know *exactly* when these neurophysiological processes permanently cease.

Some researchers have reported increased BIS activity at the time of death (Chawla et al. 2009) and during donation after circulatory death (Auyong et al. 2010). Likewise, rodent studies have documented a surge in electrical activity seconds after cardiac death (Borjigin et al. 2013) as well as a high-amplitude slow wave immediately following decapitation (van Rijn et al. 2011). It has been suggested that these electrophysiological changes may be biomarkers of the precise moment of irreversible cessation of neurophysiological function. Time-locked measurements between presumed biomarkers of death, including arterial blood pressure and electrophysiology, may confirm this hypothesis. Likewise, simultaneous measurement of cortical and brainstem function during the dying process may provide a general understanding of the relationship between the irreversible cessation of "higher order" and "lower order" cognitive functions. Indeed, such information could help adjudicate cases in which patients remain in medical limbo—bodily alive, yet brain dead. If a precise correlation between the irreversible cessation of cardiac and neurophysiological function is identified, confounding factors, such as artificial life support, may be accounted for during diagnosis. Clearly, more research is needed to parse out the complex biological processes that occur when we die.

To deny science's role in modeling the complexities of brain death in favor of defining it as a legal fiction leads us down a dangerous path. If, instead, we proceed from the assumption that a rigorous empirical approach to brain death has the power to refine our medical concepts, this may provide an objective means for defining when and how death occurs. We have argued for just such an approach, and have highlighted areas of future research that may benefit an empirically grounded model of brain death. Working toward refining our concept of brain death in this way, we believe, accurately balances scientific findings with the ethico-legal pressures of medical practice. ■

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Structuring Conversations on the Fact and Fiction of Brain Death

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It was conversation I was hearing, the free, passionate, witty exchanges of studied minds as polished as fine tools. (Steffens 1931, 115)

Recent, high-profile cases remind us that our sophisticated biomedical technologies actually render death in the clinical setting more rather than less enigmatic. Moreover, the medicalization of death masks the true nature of inquiries about death. Alexander Capron, the Executive Director of the President’s Commission that issued the original report on brain death, cautions that

the belief that defining human death is a medical matter misapprehends the undertaking. At issue is not a biological understanding of cells and organ systems, but rather a social formulation of humanhood. Through a formal declaration of the points at which life begins and ends society determines who is a full human being with rights and responsibilities. (Capron 2004)

Capron’s perspective supports a proposition that many will find disconcerting, that is, determinations of when human life comes into and passes out of existence cannot be made by *discovering*, as an objective, scientific fact of the

matter, but rather must be made by *deciding*, through a social consensus hopefully supported by the most reliable scientific information. Equally troubling to many, it may well follow from this that when the neurological criteria are met, there may simply be an opportunity, rather than a legal or moral duty on the part of the physician, to declare the patient dead.

The nature of humanhood goes to the core of disputes not only about death but also about the disposition of patients in vegetative and minimally conscious states. Eric Cassell characterized this phenomenon as “clinical incoherence about persons” in commenting on a study that found that “substantial minorities” of neurologists and medical directors of skilled nursing facilities believe that vegetative patients “experience pain, thirst, and hunger, are aware of self and environment, and are made more comfortable by intravenous fluids and tube feedings” (Cassell 1996). Even more remarkably, almost half of the physicians polled think these patients are dead, yet others believe that vegetative patients with diabetes, hypertension, or infection should be treated for those conditions, while a majority believe it would be ethical to recover the organs of these patients for transplantation. Cassell

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