

Review

Ethics review: Dark angels – the problem of death in intensive care

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Abstract

Critical care medicine has expanded the envelope of debilitating disease through the application of an aggressive and invasive care plan, part of which is designed to identify and reverse organ dysfunction before it proceeds to organ failure. For a select patient population, this care plan has been remarkably successful. But because patient selection is very broad, critical care sometimes yields amalgams of life in death: the state of being unable to participate in human life, unable to die, at least in the traditional sense. This work examines the emerging paradox of somatic versus brain death and why it matters to medical science.

“ ‘Ere. He says he’s not dead!
Well, he will be soon. He’s very ill.
I’m getting better!
No, you’re not. You’ll be stone dead in a moment.
I can’t take him like that. It’s against regulations. ”

Monty Python and the Holy Grail

In the new millennium, medical advances have changed the landscape of death by blurring the distinction of not only the timing but also the nature of death. Before the postmodern technological revolution, determination of death was simple. The old adage ‘a person is dead when a physician says so’ was the acceptable standard because the exact moment of death did not matter. But, as Whetstine’s research shows, in the age of organ transplantation, recovering living organs from clinically dead bodies raises conceptual problems [1].

Resuscitative technology can produce deceptive results and create uncertainty in determining life from death. Consider the following: in the United States, about 150 legally dead people are suspended in liquid nitrogen, awaiting a nanotechnology that will repair their fatal disease and restore them to life [2,3]. The practice of cryopreserving people immediately after they have been pronounced medico-legally dead is called cryonics [4]. A physician will pronounce a patient using cardio-respiratory criteria, whereupon the patient is legally dead, and the rules pertaining to procedures

that can be performed change radically, since the individual is no longer a living patient but declared a corpse. In the initial cryopreservation protocol, the subject is intubated and mechanically ventilated, and a highly efficient mechanical cardiopulmonary resuscitation device reestablishes circulation, thus calling into question the prior declaration of death using the cardio-respiratory standard. In some cases, the subject begins to show ‘signs of life’, including pupillary reaction and spontaneous motion [5]. This raises crucial questions, such as are such persons alive again, or were these subjects ever really dead?

The preceding scenario encapsulates our current dilemma of when and how death occurs, because an authentic death spiral can progress while support systems preserve some solid organ function. The traditional definition of death is generally accepted as ‘the irreversible cessation of the integrated functioning of the organism as a whole’ [6]. In other words, when the entity that integrates the rest of the organism dies, the organism dies with it, even though some of the cellular or tissue components within may remain independently viable for a time. Every cell within the organism does not need to be dead for the organism to be pronounced dead; only the organ of integration need be. Without this definition, organ transplantation would be impossible because putrefaction would be the only benchmark of death.

The brain has been identified as the primary integrator of the organism as a whole. The President’s Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research defines integration as “brain function that manifests as physiologic homeostasis” [7]. Thus, according to this argument, when the brain dies, the organism as a whole rapidly dis-integrates where the body can be considered a shell of organs functioning in purposeless disharmony. The problem with this definition is that the brain dies in a progression, not instantaneously or as a discrete event. Therefore, we cannot necessarily know the precise point at which integration springs from cellular function. As Michael Darwin and colleagues [8] have written,

"It is only the ideologue or the fool who acknowledges noon and midnight, but denies all the states of light and darkness that smoothly shade together to create day and night."

Harris' work [9] addresses these specific issues of subjective versus objective knowledge, and also deals with the philosophy of language and how medical and legal criteria have attempted to turn fuzzy analog issues into precise, clear-cut binary information. For example, we have arbitrarily decided the exact point at which a person becomes intoxicated and legally incompetent to operate an automobile. But selecting a particular blood alcohol level does not absolutely define drunkenness any more than a physician pronouncing death absolutely defines the exact point of death. Similarly, speeding is defined as exceeding an agreed upon, albeit arbitrary, figure. These tactics attempt to render objective truth from inherently indeterminate and value-laden terms and are often referred to as 'legal fictions'. Accordingly, brain death protocols have evolved to identify patients dead enough to bury but having organs viable enough for transplantation [10]. But is whole brain death simply another legal fiction?

Initially, for an accurate diagnosis of brain death, there must be clear evidence of an acute, catastrophic, irreversible brain injury, and any reversible conditions that may obfuscate the clinical assessment (for example, drug intoxication, hypothermia, or metabolic abnormalities) must be excluded. Subsequently, the physical examination must reveal coma, absent motor responses, absent brain-stem reflexes, and apnea. Some protocols call for a second examination, performed after a variable interval. Further confirmatory studies (for example, electroencephalography (EEG) or cerebral blood flow studies) may be ordered if there is any ambiguity in the clinical evaluation though, interestingly, according to the National Institute of Neurological Diseases and Stroke, an isoelectric EEG is not required for a declaration of brain death, thus raising further questions as to whether a brain that can emit 0.2 microvolts of electron potential on EEG ought to satisfy the criteria for 'whole' brain death [11].

Whetstine's research clearly shows that the term 'whole' brain death may in fact be a misnomer. There is evidence that a dead brain does not necessarily ensure a dead organism [12-14]. That is, integration often continues in brain dead patients if artificial interventions are employed. Further, the notion of 'whole' brain death is suspect when the brain can continue to maintain neurohormonal regulation, as demonstrated through the absence of diabetes insipidus, and modulate body temperature [15,16]. Further, patients certified brain-dead have been maintained on life support for months to deliver healthy babies, which suggests that the body may continue integration without aggregate brain input [17]. Thus, the term whole brain death may not be wholly accurate, and this imprecision has led to much discussion about when the brain is 'dead enough' to meet the criteria for

the dead donor rule, which stipulates that organ removal may not cause a person's death and that vital organs may not be removed ante-mortem.

The issue of determining death becomes further confused by the Uniform Determination of Death Act (UDDA), which, ironically, was drafted with the intent to clarify the issue. The UDDA guidelines declare that either "irreversible cessation of circulatory functions" or "irreversible cessation of the entire brain, including brain stem" constitutes death [18]. The guidelines do not elucidate how these two standards reflect the same phenomenon; the wording suggests that there are two kinds of death: brain and cardiac. This lack of a consistent standard and the intense demand for donor organs for transplantation have promoted the evolution of a particular type of organ procurement technique known as 'donation after cardiac death' (DCD) that relies solely on the cessation of cardio-respiratory function without reference to neurological function.

This dichotomy is controversial. At a strictly functional level, it can be argued that the heart is irrelevant to the diagnosis of life or death because it fails the test of integration. The heart's only purpose is to pump blood to the brain, generally considered the integrator of the rest of the body. If cardiac standstill constitutes death, a patient with a stilled heart during cardiopulmonary bypass is dead. Alternatively, is a patient alive when a viable heart beats inside a brain-dead body?

WH Sweet stated in the *New England Journal of Medicine*, "It is clear that a person is not dead unless his brain is dead. The time honored criteria of the stoppage of the heart beat and circulation are indicative of death only when they persist long enough for the brain to die" [19]. In addition, consent for organ procurement is only a valid criterion after irreversible death occurs. A patient or his or her family cannot consent to any procedure that will result in death, nor can the family consent to the patient's being dead in a defined number of minutes as has been suggested by proponents of DCD. To do so is tantamount to consenting to euthanasia.

A primary problem with the determination of death is the inability to establish precisely when it transitions from a reversible process to an irreversible event. Despite the UDDA's requirement that death must be irreversible, it failed to define the term and several ideological caucuses have developed, each with its own perspective. One caucus says that death is irreversible when the patient cannot "spontaneously" resuscitate. But how long does one have to wait to be sure that auto-resuscitation will not occur? Long enough for death of a quorum of cells? Another caucus says that death is irreversible when the patient cannot be resuscitated by any means or when resuscitation fails. Does this mean that every dying patient must be assaulted by every possible intervention if he or she is to be proven dead? A

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third caucus says that irreversibility occurs when the inherent order of the atoms that make up the brain are irrevocably destroyed. If the atomic structure of the brain is disturbed but the structural integrity of the brain is maintained, there is no fundamental barrier, given our current understanding of physical law, to recovering its information content, however labor-intensive that might be. However, if brain ultrastructure is physically destroyed, the laws of thermodynamics say that the information is irreversibly destroyed. With that consideration of irreversibility in mind, is a tobacco mosaic virus 'dead' if its constituent parts can be broken up and shaken into solution and then self-assemble again into a viable virus capable of self-replication?

Some believe that any meaningful definition of death must take into account such an information-theory criterion. Because the definition of death hinges on irreversibility and the brain is a material system governed by physical laws, physics may provide the ultimate definition of irreversibility. Cryptographer and nanotechnologist Ralph Merkle noted, "The difference between information theoretic death and clinical death is as great as the difference between turning off a computer and dissolving that computer in acid. A computer that has been turned off, or even dropped out the window of a car at 90 miles per hour, is still recognizable. The parts, though broken or even shattered, are still there. While the short-term memory in a computer is unlikely to survive such mistreatment, the information held on disk will survive. Even if the disk is bent or damaged, we could still read the information by examining the magnetization of the domains on the disk surface. It's not functional, but full recovery is possible" [20].

The problems set out here remain unresolved but will assuredly be brought to the fore as transplantation demands allow for greater interpretation of the definition and criteria of death. If our definition and criteria remain conceptually and clinically confused, we risk acceding to the authoritarian adage that death occurs when a physician says so without sufficient justification. The moment of death is unknown, but we are obligated to wrestle with these issues if we hope to differentiate the dead from the imminently dying.

Competing interests

The authors declare that they have no competing interests.

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