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## Do the 'brain dead' merely appear to be alive?

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## ABSTRACT

The established view regarding 'brain death' in medicine and medical ethics is that patients determined to be dead by neurological criteria are dead in terms of a biological conception of death, not a philosophical conception of personhood, a social construction or a legal fiction. Although such individuals show apparent signs of being alive, in reality they are (biologically) dead, though this reality is masked by the intervention of medical technology. In this article, we argue that an appeal to the distinction between appearance and reality fails in defending the view that the 'brain dead' are dead. Specifically, this view relies on an inaccurate and overly simplistic account of the role of medical technology in the physiology of a 'brain dead' patient. We conclude by offering an explanation of why the conventional view on 'brain death', though mistaken, continues to be endorsed in light of its connection to organ transplantation and the dead donor rule.

## INTRODUCTION

Before the advent of mechanical ventilation, patients without a respiratory drive would quickly become anoxic and would inevitably die within a few minutes. With the development of mechanical ventilation, it is possible to ventilate such patients, providing oxygen and removing carbon dioxide, and thus allowing the otherwise apnoeic patient to remain alive. Beneficial as this technology is for many people, it also brought with it difficult philosophical, scientific and ethical questions. Patients with severe, irreversible and nearly total brain dysfunction, and hence irreversible unconsciousness, can be maintained on the ventilator nearly indefinitely. Bracketing important normative questions about the just use of resources, medical futility and others, a fundamental philosophical and scientific question still must be addressed: are these most unfortunate patients *alive* or *dead*?

Several scholars argue that in cases of 'brain death',<sup>1</sup> the body or organism remains alive, but the person (as distinct from the organism) has died due to irreversible unconsciousness.<sup>1–3</sup> Others argue that the terms 'alive' and 'dead' in this context are covertly normative, or moral terms, functioning similarly as 'person' does in the abortion debates, and signal a moral evaluation of the permissibility of organ procurement.<sup>4</sup> On this view, to say that 'brain dead' patients are 'dead' means that they lack moral status as members of the human community, and that removal of organs is permissible—though, again, the body remains biologically alive. Another

type of view holds that whether such patients are alive or dead is in some sense a social choice, or a social construction, and that there are good social, legal and moral reasons to draw the (somewhat arbitrary) dividing line between life and death in such a way that 'brain dead' patients are on the dead side of the line.<sup>5–7</sup>

Each of the above views approaches the question of 'brain death' from a largely non-biological perspective. However, the most influential views, at least in terms of law and policy, have treated death in biological terms. The President's Council on Bioethics in 2008 reiterated this stance: "[we] reject the idea that death should be treated merely as a legal construct or as a matter of social agreement. Instead, (we) ... respect the biological reality of death" (pp49–50).<sup>8</sup>

This is not to say that the non-biological concepts are not relevant or important; they are. However, there is *also* an important question about the biological, vital status of the mechanically ventilated 'brain death' patient. Getting this biological conception right is critically important: responsible moral and policy deliberation begins with an unbiased assessment of relevant factual questions. One cannot address the difficult normative questions surrounding organ retrieval, just use of resources, withdrawal of mechanical support and so on, without first addressing the biological question: what is the vital status of this organism?

The established view regarding 'brain death' in medicine and medical ethics is that patients meeting criteria for 'brain death' are biologically dead organisms. Although such individuals show apparent signs of being alive, in reality they are (biologically) dead. The reality is masked by the intervention of mechanical ventilation on bodies with a non-functioning brain. This view was given a seemingly authoritative articulation in 1981 by the U.S. President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research,<sup>9</sup> and in 2008 the President's Council endorsed the view, though offered a new justification for it.<sup>8</sup>

The appearance/reality distinction in this context is a critical component of the established view, but it has not been carefully analysed previously (to our knowledge). In this article, we argue that appeal to this distinction fails in defending the view that the 'brain dead' are biologically dead. Furthermore, the two public bioethics committees have introduced or repeated overly simplistic distortions or outright falsehoods regarding the causal role of technology in the physiology of a patient meeting 'brain death' criteria. These erroneous factual claims continue to be repeated in the literature on the determination of death, yet impede fruitful (or even accurate) dialogue. We aim to correct that here. Finally, we

<sup>i</sup>Throughout the essay, we use scare quotes surrounding the term 'brain death' and its cognates so as to avoid the connotation that someone who meets diagnostic criteria for 'brain death' is dead or has the complete cessation of all brain functioning.



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conclude by offering an account of why the mistaken, conventional view on ‘brain death’ continues to be endorsed in light of its connection to organ transplantation and the dead donor rule, which prohibits procuring vital organs from a living donor.

## TWO BIOETHICS COMMITTEE REPORTS

The idea that patients meeting diagnostic criteria for ‘brain death’ merely appear to be alive pervades the President’s Commission report, *Defining Death*. The first page of the report states that ‘[prior] to the advent of current technology, breathing ceased and death was obvious. Now, however, certain organic processes in these bodies can be maintained through artificial means’ (p3).<sup>9</sup> The *artificial* character of these means, which is mentioned repeatedly throughout the report, ostensibly creates ambiguity in both the appearance and vital status of such unfortunate patients.

As the President’s Commission report notes, ‘their appearance resembles that of the dead as traditionally perceived: they no longer respond to their environment by sensate and intellectual activity. But their appearance also differs from that traditionally associated with the dead because mechanical support generates breathing, heartbeat, and the associated physical characteristics (eg, warm, moist skin) of life’ (p21).<sup>9</sup> In other words, although largely immobile and unresponsive, they do not look like a corpse. Indeed, with respect to some outward signs, the ‘brain dead’ may look more healthy than other patients being maintained in an intensive care unit.

However, appearances can be deceptive. The mechanical ventilator *masks* the reality of death, according to the President’s Commission report: ‘When artificial means of support mask this loss of integration [of the bodily functions of the organism as a whole] as measured by the old methods, brain-oriented criteria and tests provide a new window on the same phenomenon’ (p33).<sup>9</sup> The point about masking is repeated as follows: ‘when the mask created by the artificial medical support is stripped away what remains is not an integrated organism but ‘merely a group of artificially maintained subsystems’” (pp35–36, quoting a 1981 article by Bernat *et al.*)<sup>9 10</sup>

Writing 27 years later, the President’s Council echoed the President’s Commission on the reality of death and the mere appearance of life in the ‘brain dead’ in a ‘white paper’, *Controversies in the Determination of Death*. With respect to those diagnosed as dead according to neurological criteria, the report states, ‘The apparent signs of life that remain—a beating heart, warm skin, and minimal, if any, signs of bodily decay—are a sort of mask that hides from plain sight the fact that the biological organism has ceased to function as such’ (p3).<sup>8</sup> It further observes that those who defend the neurological standard for determining death deny that mechanically supported breathing and heartbeat are real signs of life. Breathing is ‘an artifact of technological intervention’, and the heartbeat is ‘merely the continuation of an automatic process that would quickly cease if the ventilator were withdrawn’ (p29).<sup>8</sup> In a similar vein, the report asserts that

A ventilator causes the patient’s chest to heave and the lungs to fill and thereby *mimics* the authentic work of the organism. In fact it mimics the work so well that it enables some systems of the body to keep functioning—but it does no more than that. The simulated ‘breathing’ that the ventilator makes possible is not, therefore, a *vital sign* (pp63–64; emphases in the original).<sup>8</sup>

The President’s Council departed from the President’s Commission in an important respect. The council did not accept the view that death is the cessation of integrated functioning of the organism

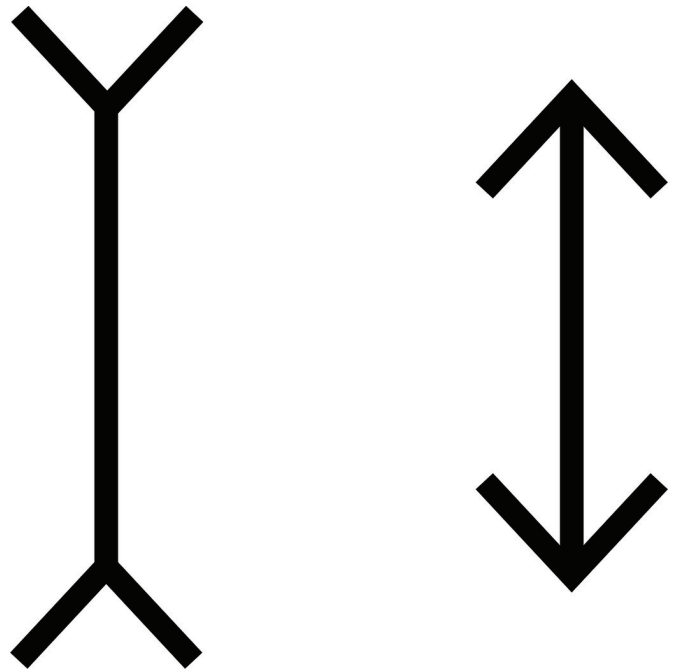


Figure 1 Müller-Lyer illusion.

as a whole; instead, it proposed a new theory of life and death based on ‘the vital work of the organism’. Nonetheless, it repeats the stance that the ‘brain dead’ merely appear to be alive and that the reality of death is masked by the application of intensive care technology. Can this stance withstand critical scrutiny?

## APPEARANCE AND REALITY

One might defend a claim that appearances are misleading in (at least) two ways. On the one hand, there are perceptual illusions in which a perceived stimulus appears to have different properties than it does. In the famous Müller-Lyer illusion (figure 1), the two lines appear to most observers to differ in length, but in reality they are the same. This illusion is readily dispelled by an empirical test, such as placing a ruler next to the two lines; in doing so, one’s perception is shifted, and we can see that the two lines are in fact the same length.

On the other hand, appeal to background knowledge can explain the reality of what is being perceived along with why the misleading appearance arises in the way that it does. For example, in watching the sun set over the western horizon, it appears as if the sun is moving relative to a stationary Earth, suggesting that the sun revolves around the Earth. But with background knowledge of modern astronomy, we can explain the reality (the Earth is revolving around the sun) as well as why appearances are misleading (our changing perspective from the surface of the Earth yields the appearance that the sun is moving). This second way of dispelling misleading appearances, which we will call the *explanatory account*, appeals to background knowledge to explain away the misleading appearances.

When the bioethics committees describe the ‘mask’ of medical technology, which hides the reality of death that has already occurred, they do not suggest that some sort of perceptual illusion is in play. It is not as if the heart only appears to be beating when in fact it is not, or that the skin only feels warm when in fact it is cold. Rather, they suggest that, *in spite of* the beating heart, warm skin and other (real) features of the ‘brain dead’ body, that organism has already died. They appeal to background knowledge of physiology and to a particular biological conception of

death to explain both the reality and why the appearances are misleading. Thus, the explanatory account is the appropriate model to understand and evaluate their claims.

Of necessity, the explanatory account relies on a background theory or conceptual framework. The explanation of the setting sun gains no purchase in adjudicating reality or in dispelling illusory appearances unless our background understanding of basic astronomy is correct. Similarly, the explanation of the allegedly illusory appearance of life in 'brain dead' patients gains no purchase unless our background understanding of the physiology associated with 'brain death' is correct, *and* the specific biological conception of organismic death to which we appeal is adequate.

The President's Commission defined death as the irreversible cessation of the integrated functioning of the organism as a whole.<sup>9</sup> By contrast, the 2008 committee acknowledged that 'brain dead' patients do not satisfy this conception of biological death. They write:

[E]ven in a patient with total brain failure [i.e., brain death], some of the body's parts continue to work together in an integrated way for some time—for example, to fight infection, heal wounds, and maintain temperature. If these kinds of integration were sufficient to identify the presence of a living 'organism as a whole', total brain failure could not serve as a criterion for organismic death, and the neurological standard ... would not be philosophically well-grounded (p60).<sup>8</sup>

Nevertheless, the council did not conclude that 'brain dead' patients were living organisms. But in order to defend their view, they had to reject the traditional biological conception of death and instead develop a new one. The council argued that a living organism was characterised by its 'vital work', the work of interacting with the environment through receptivity to signals, the ability to act on the world to obtain what it needs and a basic fundamental drive to continue to exist (p61).<sup>8</sup>

We address the council's newly proposed concept of death below. For now, it is important to emphasise that both committee reports claim that medical technology masks the biological reality of death, and both do so by invoking an explanatory account that is inextricably linked to a background concept of death. Yet, they appeal to different concepts of organismic death; in other words, they appeal to different conceptions of the underlying reality, which is allegedly masked by medical technology.

We momentarily set this issue aside because, as mentioned above, basic physiology is the other necessary element of an explanation as to why the appearance of life in the 'brain dead' is misleading. Both reports emphasise that their views are grounded in and justified by biomedical facts about physiology, and both review relevant anatomy and physiology in their reports. It is only *after* '[h]aving drawn this detailed picture of the medical facts', the council writes (p45),<sup>8</sup> that the fundamental philosophical questions can be addressed. We concur with their emphasis on empirically grounding our claims about organismic death in relevant physiology. However, both committee reports rely on overly simplistic distortions regarding the role of medical technology in the physiology of a 'brain dead' patient. It is to this issue that we now turn.

### 'BRAIN DEATH' PATHOPHYSIOLOGY AND THE ROLE OF MEDICAL TECHNOLOGY

'Brain death' can have a number of aetiologies, but the basic pathophysiology is a simple matter of fluid dynamics. Any insult, injury or illness that causes intracranial pressure (ICP) to rise precipitously can cause an irreversible coma, such as severe head

trauma, intracranial haemorrhage or severe metabolic disturbances. If ICP rises high enough that it begins to resist the driving force of blood entering the skull, blood flow to the brain begins to decrease. This results in cell damage, which in turn leads to oedema as intracellular contents extrude into the extracellular space; oedema results in a further increase in ICP, leading to a further decrease in cerebral perfusion, more cell damage and oedema, and so on in a positive feedback cycle. The outcome of this cycle is reached when ICP completely resists the driving force generated by the heart and blood vessels, and thus blood can no longer reach the brain, causing global cerebral anoxia and often brain herniation as well.<sup>11 12</sup>

Patients suspected of 'brain death' will uniformly be comatose and mechanically ventilated. The accepted procedure for diagnosing 'brain death' requires identifying the cause of coma and ruling out confounds such as sedatives, hypothermia and others. Once these prerequisites are met, the tests are clinical, with three cardinal features: unresponsiveness to pain or other stimulation (allowing for spinally mediated reflexes), brainstem areflexia and apnoea. Additional confirmatory tests may be used in special circumstances or at the clinician's discretion, but they are not generally required.<sup>13</sup>

Although state laws in the USA based on the Uniform Determination of Death Act require the irreversible cessation of *all* functions of the entire brain, patients satisfying the above described diagnostic tests can retain some brain function, particularly hypothalamic regulation of sodium and osmolarity. This is not an inexplicable anomaly; instead, it is to be expected. Some of the arteries that supply blood to the hypothalamus and the posterior pituitary are protected from increased ICP because of their anatomical location (outside the dura mater). This allows a continued blood supply during the critical period of acutely raised ICP, explaining why preserved sodium regulation is rather common among patients with 'brain death'.<sup>14</sup> Furthermore, the fact that some brain function is commonly preserved in these patients demonstrates that the President's Council's preferred terminology—'total brain failure'—is a misnomer.<sup>8</sup>

Some patients meeting diagnostic tests for 'brain death' can be supported for very long periods of time, perhaps indefinitely. It is impossible to know how many could be supported in this way since, once the declaration of 'brain death' is made, the patient will almost certainly either have life-sustaining treatment removed or will be an organ donor. However, there are at least 30 known cases of pregnant women having been physiologically supported for up to 107 days to gestate a fetus<sup>15 16</sup>; a young boy meeting 'brain death' criteria was physiologically supported for 20 years<sup>17</sup>; and more recently, a young woman has been maintained on home ventilation for over 3 years following the diagnosis of 'brain death'.<sup>18</sup>

Both committee reports assert that the presence of a beating heart in the patient meeting diagnostic criteria for 'brain death' is a function of the ventilator. This claim deserves careful scrutiny. Consider patient A, who meets diagnostic criteria for 'brain death'. Patient A has passed the acute phase of the condition, did not succumb to the serious complications associated with the process of the injury itself and is now relatively physiologically stable, 6 weeks after meeting diagnostic criteria for 'brain death'. Patient A is receiving tube feeding through the stomach and is not in need of medications to maintain blood pressure or vasopressin to regulate urine output.

Patient A's heart is beating, her skin is warm to the touch and her body shows no outward signs of decomposition. Is this all a function of the ventilator's activity for the past 6 weeks? Surely, without mechanical ventilation, the respiratory centres of her

brain will not trigger the diaphragm and intercostal muscles to expand the thoracic cavity; air will not move in and out of the lungs; and the heart would be quickly depleted of oxygen and stop. However, the presence of mechanical ventilation alone is not responsible for the beating heart. Quite the contrary.

All of the roughly 100 trillion cells that compose the human body are surrounded by fluid, known as *extracellular fluid*. This fluid is in constant motion, transported by the blood and by passive diffusion across capillary walls, and the constant movement and mixing of fluid creates a homogeneous extracellular environment throughout the body. For this reason, the extracellular fluid is known as the *internal milieu*, or internal environment, because it constitutes the environment in which all cells live and function. Extracellular fluid carries the ions, nutrients and other factors necessary for cellular functioning, and the relative concentrations of these constituents must be tightly regulated within specific boundaries for the cell to survive. This maintenance of the internal environment within specific constraints is known as *homeostasis*, and all cells both require and contribute to maintaining homeostasis.<sup>19</sup> See online supplementary table 1 for a review of some of the physiological functions involved in maintaining homeostasis of the internal environment.

Like all cells, the muscle and conductive cells of the heart require extracellular fluid whose composition is tightly regulated. The online supplementary table 1 makes clear that maintaining homeostasis of the extracellular fluid is an active process involving many mutually interdependent physiological functions; it is not a single function that can be anatomically localised to any part of the organism. All of these functions, together with mechanical ventilation and tube feeding, have been involved in keeping patient A's heart beating for the 6 weeks after the diagnosis of 'brain death'. This information is critical for evaluating the factual basis underlying the two committees' claims.

### EVALUATING THE COMMITTEES' CLAIMS

The President's Commission writes, 'One must be certain that the functions of the entire brain are irreversibly lost and that *respiration and circulation are, therefore, solely artifacts of mechanical intervention*' (p22; emphasis added).<sup>9</sup> Similarly, 'The lungs breathe and the heart circulates blood *only because the respirator (and attendant medical interventions) cause them to do so*, not because of any comprehensive integrated functioning' (p37; emphasis added).<sup>9</sup>

Is it true that mechanical support *causes* the heartbeat? Does the heart continue to beat *solely* because of the ventilator? If interpreted as meaning that the ventilator is causally sufficient for the heartbeat, this is patently false. An array of conditions is required to preserve the heartbeat, especially the homeostatic maintenance of the extracellular fluid, and this cannot be performed by the ventilator. This is demonstrated by the fact that if one were to intubate and mechanically ventilate an actual corpse, this will not result in a heartbeat or any other sign of life.

Though not causally sufficient, the inflow and outflow of air produced by the ventilator is causally necessary to maintain a heartbeat and other vital functions. However, so too is acid-base regulation and the regulation of other ion concentrations by interactions between the heart, lungs, kidneys, adrenal glands, parathyroid glands, bone, liver, intestines and red blood cells; the regulation of energy stores and metabolism via the gastrointestinal tract, pancreas, liver, muscle and fat; maintenance of blood pressure involving the heart, lungs, kidneys, adrenal glands and vasculature; continual synthesis, degradation and recycling of red and white blood cells by the bone marrow, spleen and

liver; protection from invading pathogens by the skin, lymphatic system, bone marrow and the rest of the immune system; and so on. *None* of these processes or functions are causally sufficient for the heart to beat. Rather, together they maintain the background conditions necessary for the heart (and the rest of the organism) to function. It is only given these background conditions that the intrinsic automaticity of the heart can manifest itself.

In other words, the above conditions are individually necessary and jointly sufficient for the heart to beat. And of course, continued circulation is itself a necessary condition for the functioning of all of the other organs and tissues. These physiological functions throughout the entire organism are thus *mutually interdependent*. Therefore, in view of human physiology, it is simply false that the ventilator *causes* the heartbeat and other apparent signs of life because the ventilator is not causally sufficient for the heartbeat.

On the other hand, if the President's Commission merely meant to claim that the ventilator is a necessary condition, then it is a misleading distortion to assert that the heart continues to beat *solely* because of the ventilator. It is no more (and no less) true to say that the heart circulates blood *only* because the ventilator causes it to do so than it is to say that the heart circulates blood *only* because the liver, or parathyroid glands, or skin causes it to do so. The functions performed by these organs or glands each maintain individually necessary but insufficient conditions for the heart to beat, just as the ventilator maintains the individually necessary but insufficient condition of airflow.

Despite the benefit of 27 years of clinical experience and scholarly writing about 'brain death', the President's Council makes the same false or misleading claim. They write:

As a vital sign, the *spontaneous action of breathing* can and must be distinguished from the technologically supported, *passive condition of being ventilated* ... [A]rtificial, non-spontaneous breathing produced by a machine is not ... [a vital] sign. It does not signify an activity of the organism as a whole ... and the exchange of gases that it effects is neither an achievement of the organism nor a sign of its genuine vitality (pp63–64; emphasis in the original).<sup>8</sup>

If the verb 'effect' is taken to mean *is causally sufficient*, then the claim that the passive condition of being ventilated effects gas exchange is false. The ventilator alone does not and cannot effect gas exchange. In fact, the reality is precisely the opposite: gas exchange is an achievement of the integrated functioning of the organism as a whole.

Just as the muscle and conductive cells of the heart require the appropriate extracellular milieu, so too do the cells of the alveoli, called *pneumocytes*. Type I pneumocytes are thin epithelial cells that line the alveoli and actively maintain the blood–air barrier. This barrier maintains a concentration gradient of oxygen and carbon dioxide, without which passive diffusion (hence, gas exchange) would not occur, and this barrier also prevents air from entering the blood and blood from filling the lungs. Type II pneumocytes produce a protein called surfactant, which coats the alveoli, reducing surface tension and preventing their collapse (which would render the alveoli non-functional). Once secreted, the half-life of surfactant is only 5–10 hours, and so it must be constantly generated and secreted. But like all cells, pneumocytes cannot function—and thus gas exchange cannot occur—without the appropriate extracellular environment. Furthermore, the mere exchange of gases is useless if oxygen cannot be carried in the blood, and thus the bone marrow must continually produce new red blood cells; and of course, continued circulation and thus a continued heartbeat is also necessary to transport oxygen

throughout the body; and the maintenance of the heartbeat is essentially a function of the entire organism, as described above.

Thus, the ventilator alone cannot cause the heart to beat; it alone cannot effect gas exchange; and it alone cannot provide usable oxygen to any of the tissues of the body, including the heart. The ventilator is capable of blowing air in and out of the bronchial tree; *the organism must do the rest*. In patients meeting 'brain death' criteria, the ventilator provides a necessary condition—air flow—that the organism would not otherwise provide due to brain injury, and therefore the ventilator is *life-sustaining* technology.

In sum, both committee reports rely on erroneous factual claims regarding the role of technology in a patient meeting 'brain death' criteria. If they meant to assert that the ventilator is causally sufficient for a beating heart or for gas exchange, then this is patently false. If they merely meant to point out that airflow is a necessary condition for the heart to beat, then this is radically incomplete and misleading, resulting in an oversimplified distortion of the physiological reality involved in the preserved heartbeat and other signs of life in a patient meeting 'brain death' criteria. Far from offering a 'detailed picture of the medical facts', both committees offer a false or oversimplified distortion of the medical facts. Since the proffered explanations for why the 'brain dead' merely appear to have vital signs are grounded in and dependent on erroneous claims about physiology, the explanations are undermined and should be rejected accordingly.

### THE VITAL WORK THEORY

The President's Council acknowledged that 'brain dead' patients do not satisfy the traditional view of biological death as the irreversible cessation of the integrated functioning of the organism as a whole. In order to conclude that such patients are nonetheless biologically dead, the council had to develop a new conception of death, which we call the vital work theory. On this view, biological life is not characterised by integrated functioning across multiple subsystems in the maintenance of homeostasis and resistance of entropy. Instead, biological life is characterised by the 'vital work' of an organism, which involves receptivity to signals, the ability to act on those signals and a fundamental drive to continue to exist. This new conception of death deserves comment, although briefly.

First, the vital work theory is ad hoc: it has no independent justification but is designed solely for the purpose of concluding that patients meeting 'brain death' criteria are biologically dead. The only reason that can be gleaned from the council's report for abandoning the traditional view is that this view implies that the 'brain dead' are biologically alive (pp39, 60).<sup>8</sup> But that is not a reason to abandon the traditional view; it is a reason to conclude that the 'brain dead' are biologically alive. If a new theory of organismic death is to be endorsed, then it should be appraised on the basis of the usual theoretical virtues such as coherence with other well-accepted theories, unification of disparate phenomena under an overarching conceptual or ontological framework, and simplicity; and it should be shown to be superior to the older view in these regards. But since no reason has been given to justify endorsing a new view of the nature of biological death—other than that it allegedly implies a more palatable conclusion about the 'brain dead'—the view should be rejected.

Second, assuming the vital work theory for the sake of the argument, the President's Council's insistence that spontaneous breathing counts as 'vital work' but the myriad other

physiological functions that continue in a patient meeting 'brain death' criteria do not is entirely arbitrary from the perspective of physiology. Breathing achieved by the muscles of respiration (ie, thoracic expansion) and positive pressure achieved by a ventilator both generate airflow through the bronchial tree. This is a necessary condition for the preservation of homeostasis of the extracellular fluid and thus for all cellular function. But so too is the maintenance of the blood–air barrier, which allows for gas exchange; the synthesis of red blood cells to carry oxygen; the conversion of carbohydrates, proteins and fats into glucose, amino acids and fatty acids by the gastrointestinal tract; and so on. The strategy of identifying some privileged functions that 'count' (ie, perform 'vital work') as distinct from those that do not 'count' is arbitrary and ad hoc. Necessary conditions are necessary conditions; none are either privileged or discountable.

### INTEGRATED FUNCTIONING AND THE ORGANISM AS A WHOLE

Some commentators take the position that in the case of a patient diagnosed as 'brain dead' but receiving technological support, parts of the organism remain alive but the patient is dead because the organism as a whole has irreversibly ceased to function. In this section, we address that view with particular reference to a recent discussion by Melissa Moschella. We show that this view depends on repeating the same erroneous claims about physiology propounded by the two bioethics committee reports.

Moschella<sup>20 21</sup> distinguishes the functioning of the organism *as a whole* from integrated functioning involving coordination between living parts (which need not entail the existence of an organism as a whole). Moschella acknowledges the preservation of 'low-level' integrated functioning in patients meeting 'brain death' criteria, but argues that this kind of integration does not imply that a whole organism, or a particular kind of unity, continues to exist. Rather, the organism as a whole has ceased to exist because the organism now lacks what she calls its 'master part'. Lacking this part, the 'brain dead' body 'lacks the unity proper to a human organism'; therefore, it is no longer an organism as a whole and hence is dead (p554).<sup>21</sup>

The basic idea here is that parts of the organism may remain alive, but the organism as a whole is dead because a special, ontologically privileged organ, the master part, has (mostly) ceased to function. This idea is similar to the President's Council's attempt to distinguish the privileged biological functions that 'count', or perform 'vital work', while discounting the tremendous range of preserved functions that do not count.

Moschella writes, 'I am not convinced that the functions exhibited by a ["brain dead" body] ... indicate that [the body] is itself an organism as a whole rather than an aggregation of organs and tissues inside a bag of skin, maintained in a coordinated relationship with one another through the action of external causes' (p284).<sup>20</sup> As with the bioethics committee reports, this claim is based on mistaken assumptions about physiology and the causal role of the ventilator. First, the skin is not a 'bag'; it is a living organ that plays vital roles in maintaining homeostasis via (among other things) contributing to innate immunity and maintenance of body temperature—functions maintained by the 'brain dead' body. Like all other organs, the skin both requires and contributes to homeostasis of the extracellular fluid.

Furthermore, the coordinated relationship between the various organs and tissues is *not* due to the action of external causes. The ventilator provides positive pressure and hence airflow through the bronchial tree; *the organism must do the rest*. In another passage, Moschella writes, 'the fact that an *external cause* can,

by replacing the capacity for spontaneous breathing, trigger the internal capacities of a multitude of living entities [viz., organs and tissues] ... does not imply that genuine *self*-integration is present' (p288; emphases in the original).<sup>20</sup> But the external cause *cannot* replace the capacity for spontaneous breathing (if 'breathing' is meant to include both airflow and gas exchange, as Moschella appears to be using the term). The ventilator can blow air in and out of the bronchial tree. But it alone cannot trigger gas exchange, as explained above, and therefore it cannot supply usable oxygen to any tissues of the body; and hence it cannot 'trigger' kidney function or adrenal function or immune function or liver function or skin function, and so forth. And it certainly cannot cause the functioning of all of these organs and tissues to operate in a coordinated fashion with one another.

Finally, Moschella argues that the brain is the master part because it controls the functioning of all other parts, directly or indirectly. But all organs and tissues mutually influence each other, and all are mutually *interdependent* on each other. Hence, they all control each other, directly or indirectly. Nearly all parts are involved in nearly all functions, directly or indirectly, *because all cells and organs both require, and contribute to*, the maintenance of the internal environment within conditions suitable for life. As John Hall describes it,

Each functional structure [e.g., organ or tissue] contributes its share to the maintenance of homeostatic conditions in the extracellular fluid ... As long as normal conditions are maintained in this [extracellular fluid], the cells of the body continue to live and function. Each cell benefits from homeostasis, and in turn, each cell contributes its share toward the maintenance of homeostasis. This reciprocal interplay provides continuous automaticity of the body until one or more functional systems lose their ability to contribute their share of function. When this happens, all the cells of the body suffer. Extreme dysfunction leads to death; moderate dysfunction leads to sickness (p10).<sup>19</sup>

Thus, Moschella relies on essentially the same mistaken factual claims regarding the role of technology in the physiology of a 'brain dead' patient as did the earlier committee reports. The ventilator does not cause the heart to beat. The ventilator does not cause gas exchange. The ventilator does not trigger the actions of the other organs. And the ventilator certainly does not cause the coordination of activity between the different organs. It blows air in and out; the living organism does all the rest.

### WHAT EXPLAINS THE MISTAKEN UNDERSTANDING OF 'BRAIN DEATH'?

The medical establishment and medical ethics experts are reluctant to publicly concede that the 'brain dead', in reality, remain biologically alive. Given that the practice and policy regarding vital organ transplantation has relied on endorsing the conventional view of 'brain death', it is difficult to see how the status quo of organ transplantation, which treats the dead donor rule as axiomatic, can be maintained if the conventional view of 'brain death' is jettisoned. Clearly, strong practical reasons support upholding this status quo; however, defenders of the neurological standard continue to insist on its scientific validity, apart from its role in organ transplantation.<sup>22 23</sup>

One plausible explanation for why the conventional view continues to be endorsed is that the conception of death that underlies the view is *not* a biological understanding of organismic death despite insistence to the contrary. For example, it is possible that underlying the support of many for the neurological standard for determining death is a tacit belief that 'brain dead'

patients are dead because they have irreversibly lost the capacity for consciousness. Alternatively (and not mutually exclusively), tacit appeal to something like a moral or social concept of death may also play a role. For example, some may hold that, while not completely biologically dead, patients meeting 'brain death' criteria are *as good as dead*, given their profound incapacitation and irreversible loss of consciousness; similarly, one might take such patients to lack moral standing and thus believe that they ought to be considered 'dead' for social and legal purposes, including especially for the purpose of organ procurement.<sup>4</sup>

Although support for this proposed explanation is bound to be less than conclusive, it is not entirely speculative either. First, it is interesting that Henry Beecher, who chaired the influential Harvard Medical School Committee that propounded the criteria defining 'brain death' in 1968, explicitly endorsed the consciousness-based view. Writing in 1970, Beecher asserted, 'there is need to move death to the site of the individual's consciousness, and if loss of consciousness is permanent, then to declare death' (p474).<sup>24</sup> Perhaps this claim about 'the need to move death' reflected a realisation by Beecher that the neurological standard for determining death is not consistent with a biological conception of death.

Second, Ari Joffe and colleagues recently conducted a series of surveys of Canadian paediatric intensivists,<sup>25</sup> Canadian neurosurgeons<sup>26</sup> and US neurologists<sup>27</sup> in an effort to understand their views and knowledge about 'brain death'. When asked to explain the conceptual rationale for why 'brain death' is death, in each study, only a minority selected the loss of integration rationale<sup>9</sup> or loss of the vital work of the organism rationale.<sup>8</sup> Instead, in each case, the majority selected either an irreversible loss of consciousness concept or a prognosis concept, in which the patient was considered 'dead' because respondents felt that further treatment was futile or degrading, or because respondents believed that the patient meeting 'brain death' criteria was certain to suffer cardiac arrest in hours or days.

Third, recent experimental work suggests that moral evaluations of organ transplantation can influence beliefs about death. Nair-Collins and Mary Gerend<sup>28</sup> report the results of two experiments in which participants, who were members of the general public, were randomised to read a vignette about organ procurement from an unconscious donor that was framed as either morally good or bad. Participants who were randomised to read the morally good version were more likely to believe that the unconscious donor was dead, and less likely to believe that organ removal caused death, as compared with those who read the morally bad version, even though the physiologic condition of the donor was exactly the same in both versions. Furthermore, individual differences in attitudes towards organ transplantation and euthanasia independently predicted participants' judgments of death, regardless of experimental condition. This suggests that, 'rather than concluding that organ removal is permissible *because the donor is dead*, people may believe that the donor is dead *because they believe organ removal to be permissible*' (p283; emphases in the original).<sup>28</sup>

### CONCLUSION

The neurological standard for determining death, which underwrites vital organ transplantation, has continued to be endorsed over the past 50 years. A corollary of this view is the thesis that although the 'brain dead' appear to be alive in certain respects, appearances are misleading. In reality, they are biologically dead organisms. This thesis has been defended by two US bioethics committee reports in 1981 and in 2008. Nevertheless, it cannot

withstand critical scrutiny. The science underlying the claim that the ‘brain dead’ are biologically dead organisms is weak and fundamentally flawed. Since the accepted ethical rationale for vital organ procurement from ‘brain dead’ patients relies on the validity of the neurological standard for determining death, the accepted ethical rationale is undermined as well. This is not to say that vital organ procurement is ethically unjustifiable. Rather, if vital organ procurement is ethically justified, it cannot be on the grounds that the ‘brain dead’ are (biologically) dead, but must be on some other grounds. It remains to be seen whether a new consensus will emerge regarding the ethics of vital organ transplantation, one which is not premised on demonstrably false claims about the vital status of biologically living patients in an irreversible apnoeic coma.

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## REFERENCES

- Green MB, Wikler D. Brain death and personal identity. *Philos Public Aff* 1980;9:105–33.
- McMahan J. *The ethics of killing: problems at the margins of Life*. Oxford University Press: Oxford, 2002.
- Persons LJP. *Humanity, and the definition of death*. Baltimore: The Johns Hopkins University Press, 2006.
- Veatch RM. Killing by organ procurement: brain-based death and legal fictions. *J Med Philos* 2015;40:289–311.
- Brody BA. How much of the brain must be dead? In: Youngner SJ, Arnold RM, Schapiro R, eds. *The definition of death: contemporary controversies*. Baltimore: The Johns Hopkins University Press, 1999:71–82.
- Chiong W. Brain death without definitions. *Hastings Cent Rep* 2005;35:20–30.
- 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;35:330–64.
- The President’s Council on Bioethics. *Controversies in the determination of death: a white paper by the President’s Council on Bioethics*. Washington, D.C.: U.S. Department of Health and Human Services, 2008.
- President’s Commission for the Study of Ethical Problems in Medicine and Biomedical and Biobehavioral Research. *Defining death: medical, legal, and ethical issues in the determination of death*. Washington, DC: U.S. Government Printing Office, 1981.
- Bernat JL, Culver CM, Gert B. On the definition and criterion of death. *Ann Intern Med* 1981;94:389–94.
- Smith M. Physiologic changes during brain stem death—lessons for management of the organ donor. *J Heart Lung Transplant* 2004;23(9 Suppl):S217–S222.
- Smith M, Vyas H. Management of the potential organ donor. *Paediatr Child Health* 2011;21:182–6.
- Wijdicks EF, Varelas PN, Gronseth GS, et al. Evidence-based guideline update: determining brain death in adults: report of the Quality Standards Subcommittee of the American Academy of Neurology. *Neurology* 2010;74:1911–8.
- Nair-Collins M, Northrup J, Olcese J. Hypothalamic–pituitary function in brain death: a review. *J Intensive Care Med* 2016;31:41–50.
- Powner DJ, Bernstein IM. Extended somatic support for pregnant women after brain death. *Crit Care Med* 2003;31:1241–9.
- Esmailzadeh M, Dictus C, Kayvanpour E, et al. One life ends, another begins: management of a brain-dead pregnant mother—a systematic review. *BMC Med* 2010;8:74.
- Reperinger S, Fitzgibbons WP, Omojola MF, et al. Long survival following bacterial meningitis-associated brain destruction. *J Child Neurol* 2006;21:591–5.
- Nair-Collins M. Clinical and ethical perspectives on brain death. *Medicoleg Bioeth* 2015;5:69–80.
- Hall JE. *Guyton and Hall textbook of medical physiology*. 13th ed. Philadelphia: Elsevier, 2016.
- Moschella M. Deconstructing the brain disconnection–brain death analogy and clarifying the rationale for the neurological criterion of death. *J Med Philos* 2016;41:279–99.
- Moschella M. Integrated but not whole? Applying an ontological account of human organismal unity to the brain death debate. *Bioethics* 2016;30:550–6.
- Bernat JL. The whole-brain concept of death remains optimum public policy. *J Law Med Ethics* 2006;34:35–43.
- Shemie SD, Hornby L, Baker A, et al. International guideline development for the determination of death. *Intensive Care Med* 2014;40:788–97.
- Beecher HK. Definitions of “life” and “death” for medical science and practice. *Ann N Y Acad Sci* 1970;169:471–4.
- Joffe AR, Anton N. Brain death: understanding of the conceptual basis by pediatric intensivists in Canada. *Arch Pediatr Adolesc Med* 2006;160:747–52.
- Joffe AR, Anton N, Mehta V. A survey to determine the understanding of the conceptual basis and diagnostic tests used for brain death by neurosurgeons in Canada. *Neurosurgery* 2007;61:1039–47.
- Joffe AR, Anton NR, Duff JP, et al. A survey of American neurologists about brain death: understanding the conceptual basis and diagnostic tests for brain death. *Ann Intensive Care* 2012;2:4.
- Nair-Collins M, Gerend MA. Moral evaluations of organ transplantation influence judgments of death and causation. *Neuroethics* 2015;8:283–97.