Recovery from "Brain Death": A Neurologist's *Apologia* – Revisited After 27 Years

by
D. Alan Shewmon, M.D.

In February 1997, my article "Recovery from 'Brain Death': A Neurologist's *Apologia*" was published in the *Linacre Quarterly* 64(1):30-96. Recently several people expressed interest in having it reprinted so as to be more readily available. With permission from Sage Publications, what follows is a version with typesetting errors corrected, formatted with the same pagination for the sake of consistency of future referencing. Where an update or clarification was appropriate, I inserted an endnote. The original footnotes (which were actually endnotes) are numbered as in the original publication, while the newly inserted endnotes follow and are identified by letter. The endnotes are preceded by their own specific reference section.

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by

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Summary

Beneath the nearly unanimous acceptance of the "brain death" concept lies widespread confusion surrounding both the precise signification of "brain death" and the rationale for its purported equivalence with death. As a neurologist with a keen interest in philosophy and bioethics, the author has striven over the years to articulate a coherent concept of human death, integrating clinical neurology with Aristotelian-Thomistic philosophy. This paper chronicles his gradual pendulum swing from "higher-brain" to "whole-brain" formulations, and most recently to a rejection of all purely brain-based diagnoses of death.

His earlier efforts to justify a neurological essence of human death were based on a seemingly incontrovertible thought experiment which supported the notion not only of "whole-brain death" but also of "neocortical death." Subsequent clinical experience, however, with hydranencephalic children who were nevertheless conscious required abandoning the neocortical extension of the thought experiment and critically re-examining the prevailing neurologic dogmas concerning the vegetative state. His defense of "whole-brain death" culminated in participation in the 1989 Working Group of the Pontifical Academy of Sciences, which endorsed the concept in a consensus statement. Three years later, however, further considerations and a striking clinical case forced abandonment of the axiom that the brain is the "central integrating organ" of the body and consequent abandonment of even whole-brain formulations of death.

According to this revised view, death occurs when failure of multiple vital systems and bodily processes (including the brain) progresses beyond a systems-

dynamical point-of-no-return, ordinarily (in the absence of protective therapies) presumably some 20-30 minutes or so after normothermic circulatory arrest. Although *some* "brain-dead" patients may be truly dead, it is not *because* their brains are dead but rather because of supra-critical multi-system damage; the remaining subset of "pure brain-dead" patients (with intact other organ systems) are not yet dead but are rather fatally injured and in a deep coma.

This view of death carries profound implications for transplantation ethics, but it does not necessarily preclude (at least in principle) licit harvesting of even unpaired organs of non-heart-beating donors, provided that asystole has persisted long enough for moral certainty that heartbeat and circulation will not spontaneously resume.[a] Organ removal under such circumstances would neither cause nor hasten death, nor alter the *functional* integrity of the dying person's body; thus, its moral species seems equivalent to that of removing a single kidney or part of a liver from a living donor. This approach to transplantation deserves further study by moralists.

Historically, the reasons for introducing the "brain-death" concept in the late 1960s were pragmatic and twofold: legitimizing the discontinuation of ventilators and the transplantation of unpaired vital organs. In retrospect, neither reason really required such a radical redefinition of death. Since the "central-integrator-of-the-body" rationale does not withstand careful logical and physiological scrutiny, the only remaining coherent rationale for equating "brain death" with death is the purported loss of "personhood" in a biologically live body, a rationale which entails a radical reconceptualization of "person" and which law and official medicine rightly reject but which many advocates of "brain death" implicitly or explicitly accept. History has amply demonstrated where a conceptual dissociation of personhood from biological human life tends to lead, and we would do well to reconsider whether "brain death" is any longer conceptually viable or even pragmatically necessary.

I. Prologue[1]

Most discussions of the nature of "brain death"[2] approach the topic systematically, analytically. By contrast, this presentation is organized autobiographically, according to my own conceptual evolution over the course of two decades. A systematic, thematic treatment is in preparation.[b]

I am a double convert: first from atheism and most recently from "brain death." As a medical student my early attraction to neurology was stimulated by that first conversion, and as a young neurologist my interest in "brain death" stemmed both from a philosophical interest in the mind-brain relationship and from the practical need to know the metaphysical status of the patients I was being called upon to diagnose as "brain-dead." The medical and legal professions said they were dead, as did the great majority of philosophers and theologians who addressed the question. But in the literature I could find neither a synthesis of the medical and philosophical aspects of death nor a convincing explanation for *why* death of a single organ, the brain, should *per se* constitute death of the human being, from either a biological or philosophical/theological perspective.

Along my search for conceptual clarity, I deemed it appropriate to share insights and conclusions with other interested parties. After due study and reflection, therefore, I began to write and to lecture and gradually developed somewhat of a reputation as an expert on the subject. As my immersion in "brain death" deepened, my understanding of its fundamental nature evolved – stepwise, methodically, and eventually radically. At first, I accepted (along with everyone else) that "brain death" was truly death and concluded that the most convincing reason for this equivalence implied that "neocortical death" was also death. Some years later, clinical experience forced me to reject the latter inference. Another few years later, further clinical experience forced me to reject even "whole-brain death."

Given both the profound implications of that conclusion and my own visibility, I decided to withdraw temporarily from further public discourse on the topic until the new insights had crystallized and matured. Over the next several years, my readings, clinical practice, and sociological observations have only served to reinforce the conviction that "brain death," in any and all of its neuroanatomical and semantic variations, is really not death after all but rather a state of deep and irreversible unconsciousness in a critically lesioned but still live patient. It is now time to acknowledge formally both my change of mind and the reasons for it.

That prudence demanded such a delay should be understandable. It took me some twenty years to realize the need critically to question and eventually to unlearn certain fundamental and seemingly solidly established "facts" of functional neuroanatomy. To dispute what virtually all others in my field (including many luminaries much more intelligent and experienced than myself) take for granted as almost self-evident could easily be interpreted as gross hubris, madness, early dementia, or all three. (But, as we shall see, this unanimity of opinion is very tenuous and superficial; when one begins to probe for the conceptual underpinnings, one discovers that most health-care professionals, including even neurologists, do not *really* believe the "brain-death" dogmas and explanatory clichés to which they give lip-service, or else they inadvertently harbor mutually contradictory opinions.)

In professional circles, dissenters from the "brain death" concept are typically dismissed condescendingly as simpletons, religious zealots or pro-life fanatics. The number of scholarly critiques rejecting a neurological essence of death (at least in English) can almost be counted on two hands [Browne 1983; Byrne et al 1979; Byrne et al 1982/83; Currie 1978; Evans 1990; Jonas 1974a&b; Seifert 1987, 1992, 1993; Thomas 1994].[3] The number of full-scale articles challenging "brain death" in peer-reviewed medical journals can be counted on one finger: the 1979 piece in *JAMA* by pediatrician Paul Byrne, neurologist Sean O'Reilly (soon to be deceased) and the late theologian Rev. Paul Quay [Byrne et al 1979]. Four years later the same trio, joined by law professor Peter Salsich, published a more thorough critique of "brain death" in a law journal [Byrne et al 1982/83]. More recently Dr. Byrne joined Dr. Joseph Evers in a brief critique in the journal of the Alpha Omega Alpha Honor Medical Society [Evers and Byrne 1990]. Apart from these articles, Dr. Byrne's lonely campaign has found no outlet other

than in legal [Byrne and Nilges 1993] and clerical [Byrne et al 1993] journals and as pamphlets published by pro-life organizations [Byrne 1984, 1990a, 1990b; Byrne and Quay 1983].

In such an intellectual climate, certainly no self-respecting academic neurologist would dare to entertain, let alone openly express, any objection to equating "brain death" with death. Neurologists are, after all, brain chauvinists, who tend (at least subliminally) to regard the person as the mind, the mind as the brain, and the body as nothing more than a carrying case for the brain and a means for its interaction with the external world (especially with other brains).

Thus, it should be considered noteworthy that an academic neurologist reputed as an expert on "brain death" should now disavow his own previous writings and prevailing professional dogmas and join ranks with the simpletons and physiological heretics. In more ways than one my situation over the last few years can be likened to that of the illustrious Anglican clergyman John Henry Newman during the several years preceding his shocking conversion to Roman Catholicism (although by this analogy I hardly mean to imply any similarity with either his depth of intellect or his virtue). Like Newman (cf. his *Apologia pro Vita Sua*), I feel that I, too, owe the fellowship of believers in "brain death" an explanation for my defection. Here, then, is my own *Apologia*.

II. Setting the Stage

A. Mind-Brain Relationship

At age 18 as a sophomore music major at Harvard College, I was suddenly and forcibly converted from atheism to theism while listening to a recording of Chopin's *Trois Nouvelles Études*, No. 2, Op. posth., performed by Artur Rubinstein. This intense experience sowed the seeds of an inchoate interest in neurology, because two issues that greatly perplexed me at the time were the nature of the human mind and the nature of beauty. As a materialist-atheist, I believed that all human thought and conscious experience ultimately reduced to patterns of electrical activity in the brain and that beauty, too, was in the end a mere electrophysiological epiphenomenon. To a musician, such reductionism was neither very appealing nor artistically inspiring, but it seemed an unavoidable consequence of the materialistic premise, and I was confident that – somehow, someday – Science would discover how it all worked.

At the moment of conversion, through an overwhelming grace I saw with crystal clarity that the profound and simple beauty of that work of Chopin transcended all patterns of air vibrations, electrical fields in my brain, and any other properties of the physical media through it was conveyed to my mind. Simultaneously, and as a corollary, I could see that my own mind, now transparently conscious of itself immersed in this immaterial ecstasy, itself transcended the spatial limitations of matter. Here I was, a young upstart sitting in a room at Harvard, in spiritual communion with a Polish composer across the ocean who had been dead for a century! The immateriality of my own reflective awareness became so intensely evident that it was almost palpable.

Later I would learn that this essential spirituality of the human soul in no way implies the kind of dualism that materialists typically mock as supposedly the only alternative to materialism, i.e., the Cartesian caricature of the soul as a kind of ghost somehow interacting with an essentially mechanical body. Rather, a human being is a multi-dimensional unity, in which fundamentally spiritual faculties such as intellection and volition depend for their properly human exercise in large measure on the proper functioning of the body, particularly the brain; conversely, they also affect the state of the body, particularly through the brain. The brain is the organ of all the internal senses. Brain lesions can alter one's perception of the world, one's memory, imagination, thought processes, and so on. When one voluntarily does something, the bodily movements of that hybrid immaterial/material act [cf. Braine 1992] are orchestrated by the brain. Someone with a large right hemisphere stroke may will to raise his left arm, but nothing happens even though the soul is everywhere in the body, including that arm.

Although the soul is not localized in any one part of the body but is wholly present throughout, the brain clearly enjoys a uniquely intimate role with respect to the higher faculties of the soul. Through studying Aristotelian-Thomistic philosophy as a new Catholic,[4] I came to understand that the human soul, though spiritual, is not *purely* spiritual; it is the *substantial form* (or vital principle) of the body, the basis of unification of the spiritual, emotional, sensorimotor, and vegetative aspects of each living human being [cf. Aquinas ___; Benignus 1947; Brennan 1941; Gilson 1956, 1959; Koren 1955; Maritain 1962; McInerny 1990].[5] Thus, from the start I acquired an insatiable fascination with mind-brain and soul-body relationships.

In medical school, therefore, I was keen to learn as much as possible about the brain. Afterwards, during pediatric residency, I found myself gravitating to patients with neurologic illnesses, so I decided to specialize in child neurology.

B. Two basic neurological dogmas

Every medical student in introductory neuroscience learns a basic set of facts about the brain, among which the following two are key to the issue of "brain death":

1. The brain is the *central integrator of the body.*
2. With respect to consciousness:
   a) the cerebral hemispheres (particularly the neocortex) mediate the *content* of consciousness, and
   b) the brain stem (specifically the ascending reticular activating system) mediates *arousal.*

These principles are so fundamental and so universally accepted as established beyond doubt that their truth is simply taken for granted in professional circles. As a dutiful medical student, I learned these doctrines thoroughly. Later, during neurology residency, my faith in them was deepened and reinforced by coming to know their solid grounding in Scripture (i.e., the medical literature) and Tradition (i.e., the oral teachings of venerable experts).

1. Brain as central integrator of the body

The *central integrator* doctrine follows from the fact that there is hardly a cubic millimeter in the body that is not innervated. The central nervous system receives input from virtually every part of the body, including all the sensory organs; in addition, the hypothalamus (at the base of the brain) monitors the status of the endocrine system through hormonal receptors on its neuronal membranes. The brain receives and integrates all this information and sends back controlling signals, through the efferent segmental and autonomic nerves as well as the pituitary gland, to coordinate all these same organs and tissues toward organism-level goals that transcend the perspective of the individual organs and systems. Even the immune system, long thought to function rather independently, is now known to be modulated by the brain, particularly by the limbic system, giving rise to a whole subspecialty known as psychoneuroimmunology. With respect to the rest of the body, therefore, the brain can be likened to a conductor who transforms a collection of soloists into a first-class orchestra.

Accordingly, if the brain were to be selectively destroyed, the "brain-dead" body would no longer remain a unified organism; it would no longer be a "body," strictly speaking, but a collection of juxtaposed organs that may superficially interact for a time but are actually in an early phase of disintegration (literally "dis-integration"). Thus, the term "brain death" is traditionally understood in the dual sense of *both* "dead brain" *and* "dead body," because the two are conceived as mutually implicating.

This notion appeared in preliminary form in 1972 when Capron and Kass proposed in a law journal that "brain-dead" bodies are physiologically identical to pulseless corpses and that through artificial maintenance of cardiac and pulmonary functions the traditional signs of death are merely masked [Capron and Kass 1972]. This publication imparted momentum to a nascent legislative movement to revise statutory definitions of death, beginning with Kansas in 1970, so that before long most states, Canada, and a number of European countries had come to recognize legal death as diagnosable by *either* neurological *or* cardiopulmonary criteria [President's Commission 1981 (Appendices C-E, pp. 109-158)].

An extensive exposition of the central-integrator doctrine was published in 1981 by the President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research. To this day, its monograph is still generally considered the most authoritative and official document in this country on the conceptual and legislative aspects of "brain death," and the clinical diagnostic criteria formulated by its medical consultants remain the "gold standard" for the United States [President's Commission 1981 (Appendix F, pp. 159-166)].

2. The Cortex-Consciousness Connection

The bipartite doctrine of the neuroanatomical basis of consciousness is even more solidly entrenched in the neurologic literature, especially through the many writings of Dr. Ronald Cranford [1988; Cranford and Smith 1979; Cranford and Smith 1987] and chapter 1 of Plum and Posner's textbook "The Diagnosis of Stupor and Coma," which has gone through several editions over the past three

decades and remains the classic reference on the subject [Plum and Posner 1983 (pp. 1-30)]. Dr. Cranford, a neurologist at Hennepin County Medical Center, is a world-renowned expert on "brain death" and vegetative state and was for many years chairman of the Ethics and Humanities Subcommittee of the American Academy of Neurology (AAN). Dr. Fred Plum was one of the co-coiners of the term "persistent vegetative state" (PVS) [Jennett and Plum 1972], conducted much important research on coma and its prognosis, and was a past president of the AAN. Many other important contributors could also be cited.

That the content of consciousness resides in the cerebral cortex has long ceased to be a matter for neurologic debate. Although the following illustrative quotations get a bit ahead of our story, they illustrate how firmly established the "cortex-consciousness connection" was and still is.

For example, in an article entitled "The persistent vegetative state: the medical reality (getting the facts straight)," Cranford succinctly articulated the prevailing consensus:

> The cerebral hemispheres ... contain the function of consciousness or awareness (which is more precisely located in the outer layers of the cerebral hemispheres, the cerebral cortex)... [Cranford 1988 (p. 27)]

In another discussion of PVS, he stated:

> It is a fundamental fact of neuroanatomy and neurophysiology that consciousness and the capacity to experience pain and suffering are functions of the neocortex. When a physician can determine on physical examination that there are no neocortical functions present, the patient is completely unconscious and has no capacity to experience pain or suffering.... These views on the medical reality of the PVS patient are scientific medical positions – statements of fact, not values. [Cranford and Smith 1987 (pp. 237, 241)]

Because of the increasing prominence throughout the 1980s of the ethical debate surrounding the care of PVS patients, the American Academy of Neurology deemed it expedient in 1988 to articulate the perennial doctrine authoritatively in a formal position statement, two key passages from which are the following:

> The persistent vegetative state is a form of eyes-open permanent unconsciousness in which the patient has periods of wakefulness and physiological sleep/wake cycles, but at no time is the patient aware of him- or herself or the environment. Neurologically, being awake but unaware is the result of a functioning brainstem and the total loss of cerebral cortical functioning.... Persistent vegetative state patients do not have the capacity to experience pain or suffering. Pain and suffering are attributes of consciousness requiring cerebral cortical functioning, and patients who are permanently and completely unconscious cannot experience these symptoms. [American Academy of Neurology 1989]

In a separate commentary, Drs. Theodore Munsat, president of the AAN, William Stuart, chairman of the Practice Committee, and Ronald Cranford,

chairman of the Ethics and Humanities Subcommittee, jointly underscored the position statement's importance:

> Clearly, Part I [concerning "the basic medical facts of the vegetative state"] is the most significant and most unique portion of this statement. Other medical organizations can express the same views as the Academy does in the last three parts... However, only a neurological organization can make a definite statement on the neurological facts, as the Academy does in Part I. Only a neurological society can categorically state, with sufficient expertise and credibility, that persistent vegetative state patients cannot experience (consciously perceive) pain and suffering. [Munsat et al 1989]

Dr. William Burke dared to challenge cortical orthodoxy in a letter to the editor [Burke 1990] and received the following put-down from Dr. Cranford, guaranteed to discourage all further open dissent within neurologic ranks:

> Dr. Burke objects to the Academy's neurologic position on self-awareness, breathing patterns, and ability to experience pain and suffering in the vegetative state patient... Concerning the medical-ethical-legal issues, every medical organization (AMA, AAN, Massachusetts Medical Society, etc), every learned medical-ethical organization (President's Commission for the Study of Ethical Problems in Medicine, the Hastings Center Guidelines, and Office of Technology Assessment), and every major court decision (12 of them) in the United States (except for 2 – in Missouri and Washington) that has addressed these issues disagrees with most of his views, and I see no great value in addressing each point at this time. [Cranford 1990 (p. 385)]

A year later the dogma was reinforced jointly by two Councils (on Scientific Affairs and on Ethical and Judicial Affairs) of the American Medical Association:

> Consciousness has two dimensions: arousal and the cognitive content of the aroused state. Arousal is a vegetative function maintained by deep brainstem-medial diencephalic structures in the brain, in contrast to learning, memory, self-awareness, and adaptive behavior, all of which depend on the functional integrity of the cerebral cortical mantle and its associated subcortical nuclei.... persons with overwhelming damage to the cerebral hemispheres commonly pass into a chronic state of unconsciousness (ie, loss of self-awareness) called the *vegetative state*. [American Medical Association 1990 (p.427, italics in original)]

As if these statements were insufficient, the "corticality" of consciousness was officially reiterated yet again by a special Medical Task Force on Anencephaly:

> Infants with anencephaly, lacking functioning cerebral cortex, are permanently unconscious.... Experience with other cerebral lesions indicates that the suffering associated with noxious stimuli (pain) is a cerebral interpretation of the stimuli: therefore, infants with anencephaly presumably cannot suffer. Anesthetic agents may eliminate the subcortical responses to noxious stimuli but are not necessary to minimize or prevent suffering. [Medical Task Force on Anencephaly 1990 (pp. 671, 672)]

and again still, by a Multi-Society Task Force on the vegetative state:

> Consciousness has two dimensions: wakefulness and awareness. Normal consciousness requires arousal, an independent, autonomic-vegetative brain function subserved by ascending stimuli from the pontine tegmentum, posterior hypothalamus, and thalamus that activate wakefulness. Awareness is subserved by cerebral cortical neurons and their reciprocal projections to and from the major subcortical nuclei." [Multi-Society Task Force on PVS 1994 (p. 1501)]

The multiplication of authoritative declarations pedagogically paid off. To take but one example, in the Florida Supreme Court's decision in a famous case surrounding an anencephalic infant, Judge Kogan, citing the aforementioned Medical Task Force on Anencephaly, accepted the cortical doctrine as so certain as to elevate it to even definitional status:

> All anencephalics *by definition* are permanently unconscious because they lack the cerebral cortex necessary for conscious thought. [In re T.A.C.P. 1992 (p. 590, emphasis added)]

C. The clinical phenomenon – "brain death" as total brain infarction

The solidity of professional consensus on both fundamental doctrines having been illustrated (if not over-illustrated), let us return to the young pediatric neurologist fresh out of residency, who in 1981 had just joined the faculty of UCLA Medical School. During the course of clinical duties, I was frequently consulted in cases of coma or suspected "brain death." The latter represents the extreme in the spectrum of severity of brain damage. It occurs with disproportionate frequency for a point along a continuum, for the following reason.

The brain is enclosed in the skull, which for everyone but infants is non-expansile. If the brain is injured in whatever way, like any other bodily tissue it becomes edematous. Initially the brain volume increases at the expense of the blood and cerebrospinal fluid compartments, but if the swelling is severe, intracranial pressure begins to rise sharply [Ropper and Rockoff 1993]. The brain attempts to maintain its perfusion by elevating the arterial blood pressure, but beyond a certain point this compensation fails and cerebral blood flow diminishes. But this ischemia further injures the brain, resulting in more edema. Moreover, the capillary endothelium is also often directly damaged (e.g., with a hypoxic-ischemic etiology), resulting in occlusion of the capillary lumen, even apart from excessive intracranial pressure [Ames et al 1968; Chiang et al 1968; Hekmatpanah 1970; Kowada et al 1968].

Thus, a *vicious cycle* is established in which decreasing cerebral perfusion and increasing cerebral edema reinforce one another until blood no longer enters the cranial cavity and the brain herniates through the tentorium and foramen magnum [Heiskanen 1964; Hossman 1986]. Once this process passes a critical point of no return, the brain literally self-destructs. Because of the positive-feedback nature of the vicious cycle, the destruction tends toward completion: "total brain infarction" [Swedish Committee 1984] (although if an autopsy is performed too soon afterwards, the totality of necrosis may not yet be histologically apparent [Moseley et al 1976; Pearson et al 1978; Walker et al 1975]). One straightforward sense of the term "brain death," therefore, is the strictly neuropathologic one of a "dead (necrosed) brain," which *per se* carries no direct implications regarding the vital status of the person whose brain it is.

The vicious pathological cycle can be set off by any nonspecific insult to the brain: head trauma, infection, brain tumor, hemorrhage, cardiac arrest, etc. Many of these etiologies leave the other organs relatively intact and potentially suitable for transplantation. Even in the case of cardiac arrest, since the brain is the organ

most sensitive to ischemia, if resuscitation restores the heartbeat quickly but not quite quickly enough, only the brain will be supracritically damaged. Thus, a dead brain in an otherwise relatively intact body is such a common finding in intensive care units.

It should be mentioned that the self-destruction of the brain is not *always* complete.[c] Islands of sick but not totally necrosed brain tissue sometimes remain, presumably due to inhomogeneities of intracranial pressure and/or to blood supply from extracranial collateral vessels. Thus, even in the face of proven brain herniation and intracranial circulatory stasis, isolated "brain" functions[6] can occasionally persist, including:

- hypothalamic-pituitary functions (especially absence of diabetes insipidus) [Fackler et al 1988; Hall et al 1980; Howlett et al 1989; Jørgensen 1973; Outwater and Rockoff 1984; Schrader et al 1980];
- temperature, blood pressure and heart rate regulation [Allen et al 1978 (pp. 72-73); Fackler et al 1988; Jørgensen et al 1973];
- certain brain-stem reflexes, such as the jaw jerk or snout reflex [Allen et al 1978 (pp. 72-73); Walker et al 1975]);
- residual electroencephalographic activity [Alvarez et al 1988; Ashwal and Schneider 1979, 1988; Drake et al 1986; Fackler and Rogers 1987; Plum and Posner 1983 (pp. 319-322); Spudis et al 1984];[d]
- short-latency evoked potentials [Belsh and Chokroverty 1987; Facco et al 1990; Fotiou et al 1987; Goldie et al 1981; Ropper 1984].

Even more striking neurologic functions are occasionally preserved despite massive brain herniation; they are typically attributed to the spinal cord, but debatably might involve some lower brain-stem contribution:

- cardiovascular and hormonal responses to surgical incision for organ retrieval [Conci et al 1986; Fitzgerald et al 1995; Fitzgerald et al 1996; Wetzel et al 1985];
- transient, ineffectual, spontaneous respiration-like movements [Ropper et al 1981; Turnbull and Rutledge 1985];
- development of "gooseflesh" and shivering movements [Ropper 1984]
- spontaneous jerks of limbs, decerebrate spasms, and present muscle tone [Allen et al 1978; Ivan 1973; Jørgensen 1973; Mandel et al 1982; Ropper 1984; Turmel et al 1991].
- complex movements, including arms crossing over the chest and sitting up (nicknamed the "Lazarus sign") [Heytens et al 1989; Jordan et al 1985; Ropper 1984].

Whether or not such preserved functions contradict the *totality* of "total brain infarction," they are at least compatible with the notion of destruction of the brain *as an organ*, or so-called "whole-brain death" in the sense of "death of the brain as a whole" [Bernat 1991].

D. The philosophical implication – "brain death" as death

1. Chaos beneath consensus

Although professional opinion was virtually unanimous that the neuropathological state of total brain infarction represented death of the patient, I

learned early on that there was much less consensus surrounding the *reason* for that equivalence; in fact, the more I read, the more conceptual chaos I discovered.

For example, in 1978 a prominent neurosurgeon at Harvard Medical School, Dr. Peter Black, published a major two-part review article on "brain death" in the *New England Journal of Medicine*, destined to become a standard reference for years to come [Black 1978a&b]. Remarkably, given the article's import, not a single sentence was devoted to an explanation of *why* "brain death" should be equated with death. Rather, the author elaborated on two fundamental interpretations of the term "brain death" and their corresponding diagnostic criteria: "brain death as inevitable bodily death" and "brain death as extensive brain necrosis."

The first interpretation would have us believe that "brain death" should be regarded *as* death because it inevitably *leads to* death. This oxymoronic notion was merely a continuation in the tradition of semantic confusion spawned by the famous Harvard Ad Hoc Committee, the title of whose landmark report of 1968 – "A definition of irreversible coma" – implied that "brain-dead" patients are really alive (insofar as the term "coma" is inapplicable to corpses) [Beecher et al 1968]. Unfortunately, the only conceptual alternative reviewed by Black, namely "brain death as extensive brain necrosis," was (in the absence of other physiological and philosophical considerations) as irrelevant to the distinction between life and death as the notion "arm death as extensive appendicular necrosis."

Despite the complete absence of any suggested rationale, the equivalence of "brain death" with death was simply taken for granted in the article, as a matter of professional and societal consensus. Nevertheless, telltale Freudian slips betrayed a seeming lack of conviction on the part of even Black himself. For example, the introduction to Part 1 states: "This paper... will ultimately suggest that whole-brain damage from which survival has never been seen can be diagnosed by many different sets of criteria..." (p. 338) (Not even the mere *possibility* of survival can be logically entertained with respect to what one believes to be a corpse.) More overtly, in the section of Part 2 entitled "Brain death and public opinion," while intending to reassure the reader about the accuracy of neurological diagnoses of death, Black ironically undermined the very concept: "No set of [diagnostic] criteria currently proposed by physicians seems to allow for the possibility of long-term survival, let alone recovery, however. *Patients fulfilling any one of them die within a few months* even with maximum therapeutic support." (p. 399, emphasis added)

That such a notion of "brain death" should represent the pinnacle of ontological profundity, emanating as it did from one of the most prestigious medical schools and elevated to the "Medical Progress" section of one of the most prestigious journals, suffices to prove the extent of the conceptual anarchy prevailing at the time (and still today).

2. Three fundamental approaches

Within the chaos surrounding the rationale for the equivalence of "brain death" with death, however, I discerned running through the "brain-death" literature what seemed to be three fundamental schools of thought (see Table 1),

two of which corresponded to the two fundamental neurological dogmas discussed above.

Table 1. Rationales for equating "brain death" with death

I. Pseudo-rationales
   A. *Oxymoron* ("Brain death" is death because it inevitably leads to death.)
   B. *Ostrich approach* ("Brain death" is death of the brain - a neuropathologic entity – and here are diagnostic criteria for it; don't bother me with abstract philosophical speculations.)
   C. *Utilitarianism* ("Brain death" is a legal fiction invented to legitimize the transplantation of vital organs that would otherwise be wasted.)
   D. *Nominalism, cultural relativism* (Death is however society chooses to define it. "Social death.")

II. Loss of somatic integrative unity
   A. *Somatocentric* ("Brain death" is death because it is physiologically the same as traditional death, the loss of vitality merely being masked by the artificial replacement of cardiopulmonary functions.)
   B. *Neurocentric* (Traditional death is death only because it includes "brain death," i.e., destruction of the body's "critical organ.")
   C. *"Brain-stem death"* (the "physiological kernel" of "whole-brain death")

III. Loss of essential human properties or personhood
   A. *Psychocentric* (Traditional death and "brain death" are both death, because they both entail a loss of *personhood*, understood as mind or capacity for consciousness, which in turn depends on the integrity of the brain – regardless whether the body remains biologically alive or not. "Cognitive death." "Mental death.")
   B. *"Neocortical death"* (the "psychological kernel" of "whole-brain death")

The first encompasses what ultimately amount to mere *pseudo-rationales*. One is the *oxymoron* treated in Part 1 of Black's review article, namely: "'Brain death' is death because it inevitably leads to (somatic) death." Another is what could be called the *"intellectual ostrich approach,"* corresponding to Part 2 of Black's article, which implicitly suggests: "'Brain-death' is the death of an organ, the brain, and don't bother me with abstract philosophical speculations. If the experts agree that this neuropathologic state corresponds to death, that's good enough for me."

A third kind of pseudo-rationale is that "brain death" is ultimately a *utilitarian legal fiction* invented to legitimize the harvesting of vital organs from actually living patients. Although rarely stated so bluntly, this view appears sometimes indirectly as an inference "between the lines" and other times more or less explicitly: for example, in the Harvard Ad Hoc Committee report [Beecher et al 1968], in commentaries by the Committee's chairman, Dr. Henry K. Beecher [Beecher 1968, 1969; Beecher and Dorr 1971], in the early history of vital organ transplantation (begun in the complete absence of medical or societal consensus

regarding the nature of "brain death") [Devita et al 1993], and in the candid introspections of famous cardiac transplant surgeons [Castelnuovo-Tedesco 1971]. Despite more than two decades of educational effort, the medical establishment has been unable to convince large sectors of society and even of the health-care professions that "brain death" is really death and not merely a legal fiction [Shewmon 1992; Youngner et al 1985; Youngner et al 1989].

A fourth kind of pseudo-rationale, sometimes coupled with the third, has its philosophical roots in medieval *nominalism*, which denies universal natures or essences in things, claiming, rather, that things are categorized and understood according to however we happen to name and define them. Applied to patients with destroyed brains, this metaphysic engenders the following line of reasoning: "We might as well call them 'dead' because they are basically 'as good as dead.' Besides, death is ultimately not so much a biological state as a social construct; death is whatever a given society chooses to define as death at a given moment in history." [Beecher and Dorr 1971; Caplan 1988; Charron 1975; Dworkin 1973; Lachs 1988; Pernick 1988; Scott 1988; Walters and Ashwal 1989]. Others would prefer to make the freedom of definition relative to the individual rather than to society [Sass 1992; Veatch 1989].

The second broad category of rationales equates "brain death" with death, because, philosophically, death of any living organism is most properly defined as the loss of its immanent dynamism at the level of the organism as a whole (i.e., *loss of its bodily integrative unity*), and, medically, such loss is considered instantiated in destruction of the brain. Within this overall view, three main variations can be distinguished.

The first, which could be called *"somatocentric,"* was originally proposed in 1972 by attorney-ethicist Alexander Morgan Capron and physician Leon Kass [Capron and Kass 1972]. It considers "brain death" as essentially the same physiological state as traditionally diagnosed death, except that the absence of innate, spontaneous circulatory and respiratory functions is masked by artificial life-support technology. This view was later canonized, together with the "complementary" (p.32) "primary-organ" approach, by the U.S. President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research in its signal monograph on the determination of death [President's Commission 1981 (pp. 32-38)]. Concurrence with the Capron-Kass analysis was perhaps not surprising, given that the Commission's executive director was the same Alexander Capron, who also continued thereafter to advance this rationale for the equivalence of "brain death" with death [Capron 1987a&b; 1989].

Despite the augustness of the body of endorsers, I was unconvinced by this line of reasoning, because it is simply not accurate to assert that cardiac and pulmonary functions in a "brain-dead" body are maintained artificially. The ventilator replaces the function not of the lungs but only of the diaphragm and intercostal muscles; the heart and lungs both continue to function perfectly well. The spontaneity of heartbeat and the metabolic interaction among the other organ systems by means of the circulating oxygenated blood in no way resembles the physiological state of a corpse declared dead by traditional cardio-pulmonary

criteria. Although all these vital functions would soon cease if the blood were to become deoxygenated due to apnea, such dependence *per se* on the mechanical ventilator is no more an argument for equating "brain death" with death than for equating any other cause of apnea with death.

A second approach within the "integrative unity" school could be designated as *"neurocentric."* In 1978 Korein proposed a thermodynamical explanation of "brain death" as loss of the "critical system" of an entropy-opposing composite of mutually interacting parts, a model he continued to use later [Korein 1978, 1984, 1986]. In 1981 Bernat and colleagues proposed that the physiological essence of human death is destruction of the brain, on the basis of loss of functioning of the "organism as a whole" [Bernat et al 1981], a viewpoint which Bernat in particular has been championing ever since [Bernat 1984, 1991, 1992, 1994; Bernat et al 1982; Culver and Gert 1982]. This view is, in a sense, the flip-side of the Capron-Kass approach. For both, death is a unitary phenomenon, traditional cardiopulmonary death and "brain death" being essentially one and the same thing. But whereas the former says that "brain death" is death because it is equivalent to cardio-pulmonary death, the latter says that cardio-pulmonary death is death precisely because it includes "brain death," i.e., destruction of the body's primary, central integrating organ. Thus, "[t]he whole brain formulation is not a new definition of death but simply makes explicit the implicit traditional definition of death" [Bernat 1994 (p. 118)].

This explanation made much more sense to me. What was less clear, however, was the minimum extent and distribution of *subtotal* brain destruction necessary to instantiate this concept. Virtually every commentator agreed that not every single cell in the brain had to be destroyed in order for the brain *as an organ* to be destroyed. "Whole-brain death," in the sense of death (necrosis) of the entire brain, therefore seemed anatomically overinclusive. On the other hand, "whole brain" loosely understood as "brain as a whole," was diagnostically vague. The more inclusive interpretation at least enjoyed the pragmatic advantage of minimizing the probability of false positive diagnoses potentially deriving from mistaken assessments of "brain as a whole" or "partial-brain death."

The third current within the "integrative unity" school proposed that the essence, or "physiological kernel" of "brain death" is the irreversible loss of function of the brain stem, insofar as that is the part of the brain where somatic integration takes place (especially if the anatomical extent of "brain stem" is understood broadly to include the hypothalamus). This so-called *"brain-stem death"* was (and is) the officially recognized version of "brain death" in the United Kingdom [Conference of Medical Royal Colleges 1976, 1979], and many of its advocates' criticisms against American insistence on the whole-brain requirement seemed to me quite logical [Lamb 1985; Pallis 1982, 1983a&b, 1990]. Insofar as the brain stem includes the reticular activating system, its destruction produces not only loss of somatic integration but also permanent coma, and hence would seem functionally equivalent to "whole-brain death" in every important respect. The main problem with this proposal, as I saw it, was that pure "brain-stem death" entailed a theoretical possibility of dissociation between the consciousness aspect and the somatic integration, resulting in

potential for the anomaly of a conscious "corpse" (to be explained in greater detail further on).

This brings us to the third major category of rationales for the equivalence between "brain death" and death, namely the *loss of personhood*. For human beings, at least, life and death are personal, not merely biological. If through a brain lesion, I permanently lose the essential characteristics that make me *me*, as distinct from someone else or some*thing* else, then *I* no longer exist. These requisite qualities are typically held to be psychological in nature and are ultimately founded on reflective consciousness (a *"psychocentric"* view of death). Of course, when I sleep I do not cease to exist, because the potential for awakening remains. But if there be no such potential, so the argument goes, then neither would there any longer be an *I*, even if the body that used to be mine were to remain biologically alive. Since, the neuroanatomical locus of the content of consciousness is the cerebral cortex, *"neocortical death"* is often proposed as the essence or kernel of "whole-brain death" – although it is a "psychological kernel," in contrast to the "physiological kernel" of so-called "brain-stem death" [cf. Cranford and Smith 1987; Puccetti 1976, 1988; Zaner 1988].

Advocates of "neocortical death" have raised many legitimate criticisms of both "whole-brain" and "brain-stem" death, especially the arbitrariness of assigning critical importance to lower brain-stem functions, while dismissing as irrelevant all the integrative functions of the spinal cord [Bartlett and Youngner 1988; Veatch 1975, 1978a&b, 1988, 1989, 1993; Youngner 1987; Youngner and Bartlett 1983]. On the other hand, critics of "neocortical death" have emphasized the counterintuitiveness of calling a spontaneously breathing body "dead" and the repugnance of treating it so (e.g., burying it or dissecting it in an anatomy class while still breathing) [Bernat 1991, 1994; Capron 1987a&b; President's Commission 1981 (pp. 39-41)].

Moreover, to make the essence of "brain death" the loss of "personhood" seemed to invite abuse against mentally impaired individuals. The concept of "higher-brain death" is but one step removed from that of "mental death," popularized in Germany during the 1920s and '30s through a book by jurist Karl Binding and psychiatrist Alfred Hoche entitled "Permission to Destroy Life Unworthy of Living" [Binding and Hoche 1920]. Historians of the Nazi medical crimes unanimously agree that the concept of biologically live human "nonpersons" played a key role in the professional acceptance of the "euthanasia" murders of the mentally ill, retarded, demented, and other "useless eaters" perceived as "mentally dead" and as "foreign bodies" in society [Alexander 1949; Caplan 1992; Lifton 1986; Wertham 1973]. Such concerns were all the more justified, considering how at times in the contemporary literature "neocortical death" is used interchangeably with culturally relativistic cognates such as "cognitive death" [Beresford 1978; Fletcher et al 1986], "intellectual death" or "social death" [Beecher 1968], together with the acceptability within intellectual circles and professional journals of regarding the personhood of the severely retarded as at least a debatable topic [Fletcher 1972; Lachs 1976; Singer 1983].

To summarize, the statement of Bernat [1994 (p. 115)] concerning the mid-

1990s could to a large extent have been attributed to the previous decade, at least as regards adults and older children: "the concept underlying brain death and the bedside practice of declaring brain death had become so well accepted in Western society that many no longer regarded it as an important philosophical or ethical issue." Indeed, virtually everyone seemed to agree that "brain death" was legitimately regarded as death; nevertheless, beneath this superficial consensus there was really very little agreement as to precisely what was meant by "brain death" or (especially) as to the *reason* for its equivalence with death, and corresponding to each explanatory proposal was a logical extension to a *different* distribution of subtotal brain destruction claimed to be the essence of "whole-brain death" and of death.

3. Personal perspective - early 1980s

Thus, at the beginning of my academic career in the early 1980s, the world literature on "brain death" reflected a chaotic morass of conflicting opinions, each of which seemed to have elements of truth but also an admixture of conceptual weaknesses and occasionally even self-contradictions. None of the rationales for equating "brain death" (in any of its variations) with death was entirely convincing or definitive. To make matters worse, most of the general public, and even some professionals who should have known better, seemed to give only lip service to the "brain death" concept, inwardly believing that such patients were really alive. There were also a few objectors to any sort of neurologically based notion of death, mainly among certain philosophers [Currie 1978; Jonas 1974a&b], orthodox Jews [Bleich 1989; Mendelsohn 1987; Soloveichik 1978], evangelical Christians [Heather 1990], and pro-life groups [Byrne 1984, 1990a&b; Byrne and Quay 1983; Lincoln and Grimstad 1989; Mendelsohn 1987; Nilges 1990; Senander 1989]. Neither did I find their arguments very persuasive, because they seemed to be based either on idiosyncratic interpretations of scripture or on ancient tradition inapplicable to modern technological medicine, or on a simplistic, univocal notion of "life" and "death" that failed to take into account the physiological hierarchy in living organisms (i.e., rejecting the possibility that vitality might be present at the level of cells, organs and tissues but not necessarily at the level of the organism as a whole).

As a Catholic convert desirous to respect the transcendent dignity of the human person and the sacredness of the body, I studied both Magisterial pronouncements and opinions of orthodox theologians and philosophers relevant to the issue. Not surprisingly the Church had issued no official statement on "brain death," but appropriately left the clinical determination of death to the proper competence of the medical profession. The only thing that even obliquely touched the philosophical question was Pope Pius XII's 1957 address to an International Congress of Anesthesiologists, in which he alluded to a distinction between the life of an organism and the mere life of cells [Pius XII 1957]. Although not specifically addressing the issue of "brain death," the pope's recognition of the analogical nature of "life" and the existence of hierarchical levels within living organisms at least left conceptual room for the loss-of-

integrative-unity rationale (against its vitalistic critics).

I came to appreciate how theological formulations of death in terms of a "separation" of the soul from the body tend to be misunderstood in a Platonic-Cartesian manner, as though the soul were a pure spirit somehow attached to, or imprisoned in, the body. This has never been the view of the Church, which for centuries has recommended the philosophical system of Thomas Aquinas, who, following Aristotle, regarded the soul as the life-principle, the principle of immanent dynamism and unity, the "substantial form," of the body [Aristotle __; Aquinas __; Pius X 1914; Pius XI 1923; Pius XII 1950]; moreover, this role of the soul with respect to the body was even dogmatically defined by the Council of Vienna under Pope Clement V in 1312 [Denzinger 1957]. Accordingly, the presence or absence of the soul, from a theological perspective, corresponds precisely to the presence or absence of unity and immanent dynamism at the level of the organism from a biological perspective. In the words of Pope John Paul II [1989], "[death] occurs when the spiritual principle which ensures the unity of the individual can no longer exercise its functions in and upon the organism, whose elements, left to themselves, disintegrate."

Although this vitality is clearly lost within hours after cardio-circulatory arrest, the theological literature had virtually nothing to say about the relatively recent and technically complex issue of "brain death." The majority of Catholic philosophers and theologians who did address the subject basically accepted the idea that "brain death" was death by virtue of destruction of the central integrating organ, which they quite appropriately accepted as a factual premise on the testimony of the medical profession [Grisez and Boyle 1979; Moraczewski 1980; Moraczewski and Showalter 1982],[7] although there were notable exceptions such as the late Rev. Paul Quay [Byrne et al 1979; Byrne et al 1982/83; Quay 1993]. A 1983 "Resource Paper" of the National Conference of Catholic Bishops was at least open to the notion that total brain destruction might constitute death, although it expressed serious reservations about how the "brain death" concept was being understood and implemented in practice [National Conference of Catholic Bishops 1983]. By no means does acceptance of "brain death" as death imply a Cartesian view of the soul, only "seated" in the brain rather than in the pineal gland; it simply implies that once the brain is embryologically developed and the body comes to depend on it for integrative unity, the brain's integrity remains a critical requisite for the body's "informability" by the soul.

In 1985 the Pontifical Academy of Sciences convened its first multidisciplinary Working Group on the Artificial Prolongation of Life and the Determination of the Exact Moment of Death, which produced a consensus statement acknowledging the equivalence of "whole-brain death" with death [Chagas 1986 (pp. 113-114)]. As the opinion of the Academy's consultants, this carried no Magisterial weight, but at least the Vatican's willingness to publish the document under its own auspices seemed to imply at least no fundamental opposition to a brain-based criterion of human death.

For the sake of the clinical situations in which I was immersed, it seemed imperative to resolve in my own mind the metaphysical status of patients with

destroyed brains. Were they alive and deeply comatose, or dead? Should they be given the sacrament of the sick, or was it too late? When should death be certified – when the brain destruction occurred or when the ventilator is discontinued and cardiac arrest ensues? But most pressing of all was the morality of vital organ transplantation: was the excision of a beating heart from a body with a dead brain an act of direct killing or not?

To answer these questions, first, the medical aspect had to be clarified according to sound physiology and sound logic; second, the methodological and terminological chasm between biology and philosophy had to be bridged in order to produce a coherent, integrated conceptualization of death. As one who considered himself at least somewhat knowledgeable in both areas, I set myself to the task.

III. The metaphysics of "brain death" and vegetative state: the *Thomist* article

Given the apparent inconclusiveness of the standard explanations of "brain death," I sought a fresh approach. A thought experiment occurred to me that seemed definitively to demonstrate that "brain death" was death; moreover, it seemed integrable with the traditional Aristotelian-Thomistic hylemorphic (matter-form) view of the body-soul relationship. I therefore decided to test the water by writing a synthetic article with both medical and philosophical depth. Attempts to solicit feedback on the project were unfruitful, with medical colleagues declaring incompetence to comment on the philosophical aspects and philosophers declaring incompetence to comment on the medical aspects, and no one offering substantive criticism.

The final manuscript was clearly inapt for a medical journal on account of both its length and its philosophical orientation. It also seemed out of place for a philosophy journal, given the physician authorship and the permeation with neurological terminology and data. But it seemed less unsuitable for a philosophical journal than for a neurological one, so in July 1983 I submitted it to *The Thomist* under the title, "The metaphysics of brain death, persistent vegetative state, and dementia." Its acceptance took over half a year and publication nearly another whole year, so it did not actually appear in print until January, 1985 [Shewmon 1985]. Little did I anticipate the course of events to be spawned by such an eclectic article in a relatively obscure journal.

Although the article's main focus was "brain death," it also considered vegetative state and dementia, because all three are related as degrees of severity along a neuropathological spectrum and because the analytic approach to "brain death" seemed to carry implications for the other two conditions as well. Here, then, is a brief summary of the line of reasoning set forth in the *Thomist* article.

A. The thought experiment

It seemed that an understanding of "brain death" could be reached indirectly by first gaining insight into the easier question, "What is the minimum part of a living human body that alone still constitutes that body?" Imagine,

hypothetically, that in a certain country capital punishment is carried out by decapitation, and that for the sake of scientific investigation two teams of surgeons are on the scene. As soon as the head comes off, one team immediately attaches the head's major blood vessels to a cardiopulmonary bypass machine, while the other team ligates the bleeding vessels of the body, intubates the trachea and attaches a mechanical ventilator. Both the head and the headless body are then maintained in an experimental intensive care unit for as long as possible.

It is relevant to mention here, in answer to a particular later criticism of the thought experiment, that, although such an experiment would never *in fact* be performed on account of the obvious ethical obstacles, it is nevertheless *in principle* technologically perfectly feasible. Similar experiments have actually been successfully performed on monkeys, including even brain and head transplants between animals [White 1968, 1986; White et al 1963; White et al 1964; White et al 1965; White et al 1971]. Moreover, hard as it is to believe, a similar experiment actually *has* been carried out on *human beings.* In the mid-seventies an infamous study took place in Finland, headed by an American pediatrician, funded by the U.S. National Institutes of Health, and published in a respectable medical journal, in which human fetuses of 12-21 weeks' gestation, aborted live by hysterotomy, were utilized to study fetal cerebral metabolism [Adam et al 1975]. Although the investigators claimed to have waited until spontaneous cessation of heartbeat before beginning the experiments, the fetuses were certainly not dead, much less "brain dead" (otherwise there would have been no cerebral metabolism to study). The methodology involved surgically decapitating the fetus and attaching the head to a pump-oxygenator. Chemicals were injected into the arterial side, and concentrations of various metabolites were compared between arterial and venous blood. The published report did not state how long the heads were kept alive, but it was at least 90 minutes.

Let us therefore return to the less grisly imaginary world of the thought experiment, in which a particular prisoner, Smith, is so executed. Which part is now Smith – the head or the decapitated body? It must be one or the other, or else neither (i.e., Smith died despite both parts being kept "alive"). It seemed clear to me that the head had to be Smith, because all his mental functions are mediated through his brain, which remains intact and functioning in the head. If one were to ask the headless body, "Are you Smith?", it would answer nothing; but if one asked the head, "Are you Smith?", it would answer, "Yes" (not vocally, of course, but through eye blinks, mouth movements, or other signs). It is not that Smith's head has been amputated from his body, but rather that his arms, legs, and torso have all been collectively amputated from his body (all that is left of which is the head).

If the head now constitutes Smith's body (severely mutilated and reduced though it may be), what is the mechanically ventilated body in the adjacent bed, with four extremities and all (noncerebral) internal organs and which strongly resembles Smith's former body? The heart beats spontaneously; the kidneys produce urine; (presumably) wounds heal. This collection of organs and tissues seems to have all the physiological properties of a typical "brain-dead" body.

But the soft tissues and the bones of the isolated head do not really contribute in

an essential way to the identity of Smith. Therefore, suppose that, instead of a crude decapitation, the surgeons had merely removed the brain directly, connecting its major vessels to a cardiopulmonary bypass machine, and placed it in some appropriate fluid bath. The cephalic bones and soft tissues are left with the rest of the body, and tracheal intubation is performed in the standard manner. Now we have a body that is identical in every way to a "brain-dead" body; the only difference is in *how* the brain came to be missing (in the one case through pressure-induced infarction and in the other through physical removal). And on an adjacent table sits a beaker with a living brain, which constitutes the even more severely mutilated body of Smith; the only essential difference is that he has now lost all means of communication with the rest of the world.

This hypothetical scenario provided the backdrop for quite a convincing proof that "brain death" is death: if the isolated brain is the body (though greatly reduced) of a conscious person and if the brainless body whence it came is physiologically equivalent to a "brain-dead" body, then to remove the life-sustaining equipment from the latter would not kill the person; rather, destroying the brain would kill the person.

What, then, *is* the brainless body, given that it contains living cells, organs and tissues but is clearly no longer vivified ("informed") by Smith's soul? Metaphysically speaking, a "substantial change" has taken place. Whereas formerly there was one living organism (Smith), now there seem to be at least two: one is Smith mutilated and the other(s) is (are) either some nonpersonal living organism that does not normally exist in nature or a nonunified collection of many living cells. There are, after all, clear precedents for substantial change from higher to lower levels of life. Leukocytes or fibroblasts can be removed from a human body and maintained in tissue culture; some will multiply. These cells obviously are not human beings but rather belong to a new category of unicellular living entities. It seemed to me that "brain death" was an analogous substantial change from one multicellular organism to multiple unicellular organisms.

B. Rostral extension of the thought experiment – persistent vegetative state

Consider now the isolated living brain, which is the reduced body of Smith. Is the *entire* brain necessary for him to remain alive? Certainly not. Victims of strokes have various parts of the brain destroyed, and they do not necessarily die or cease to be themselves as a result; therefore, the isolated brain can be lesioned without destroying it as an organ (and hence without killing Smith). So, let us ask about the brain the same question that we had asked originally about the body: What is the minimum part of a *brain* that alone still constitutes that brain, thereby constituting the theoretically minimum physical substrate for a person's bodily life?

Since, according to accepted neurological dogma, the content of consciousness is mediated by the cerebral hemispheres (particularly the cortex) and all the brain stem does (*vis a vis* consciousness) is to keep the cortex awake, perhaps the brain stem might not be absolutely essential for Smith's brain-body if it were somehow possible to keep his cerebral hemispheres awake apart from the brain-stem reticular activating system. As I was struggling with this part of the puzzle, I

stumbled across an article that provided a solution. The German neurosurgeon Hassler reported success in arousing patients comatose from discrete brain-stem lesions; this he accomplished by artificially stimulating the reticular activating system through an electrode stereotactically placed just rostral to the lesion [Hassler 1977]. Amazingly, the patients woke up. Although severely disabled, their facial expressions and eye movements indicated recognition of relatives, and they would cry when visiting loved ones left the room. Then, when the stimulation was turned off, they immediately lapsed back into coma. (For obvious ethical reasons, this line of therapeutic experimentation has not, to my knowledge, been further pursued.)

The implications of Hassler's findings for the thought experiment were unmistakable. Suppose we removed the brain stem from Smith's isolated living brain but kept him awake by electrically stimulating the diencephalic stump of the reticular activating system. He would still be alive and conscious in an even further reduced body. Therefore, the essential structure of the brain, *vis a vis* consciousness and personhood, seemed to be the cerebral hemispheres.

But now suppose that the brain stem had been left in the brainless body from the beginning. It would be physiologically equivalent no longer to a "brain-dead" body but rather to a "neocortically dead" one, i.e., to a body in a *persistent vegetative state*. The intact brain stem controls breathing, blood pressure, coughing, etc. This is clearly a living, physiologically integrated body from the biological point of view; moreover, it requires no intensive-care technology to stay alive, but only tube feedings and basic nursing care. But it has no mind, no consciousness; as the colloquial saying goes, "the lights are on, but no one's home." Although this body looks in every way like Smith in a PVS (because it used to be his body), it is actually not, because Smith is over there, conscious, imprisoned in the electrically stimulated cerebral hemispheres.

Thus, it seemed that if we follow the thought-experiment through to its logical conclusion, we are forced to conclude that a person dies when the cerebral hemispheres are destroyed, and that the remaining body in a persistent vegetative state is not the person anymore. From the metaphysical point of view, as with "whole-brain death," a substantial change has taken place, except this time not to multiple unicellular organisms but to a single nonpersonal mammalian organism that superficially resembles a human being. Whether this conclusion was attractive or not, it seemed to follow inescapably from the basic medical facts.

The Hassler report also suggested a rather definitive argument against the notion of "brain-stem death." Recall that the British school maintained (and still maintains) that "brain-stem death" is the "physiological kernel," or essence, of "whole-brain death," because: (1) the brain stem is the part of the brain where somatic functions are integrated, especially if one includes the hypothalamus as an extension of the brain stem, and (2) in the absence of brain-stem activation, the cerebral hemispheres remain in a permanent state of coma [Pallis 1982, 1983a&b, 1990]. But in light of the observations of Hassler, if the brain stem were destroyed but electrical stimulation were applied to the cerebral stump of the reticular activating system, the person could be kept awake and conscious through the intact cerebral hemispheres. The concept of "brain-stem death"

therefore made as much theoretical sense as that of a "conscious corpse."

After considering "neocortical death" as the complement of the person living in isolated cerebral hemispheres, I went out on a limb and speculated whether the thought experiment could be extended further still. At the theoretical extreme, the person would be living in artificially stimulated isolated association cortex, with the primary sensory and motor cortex left in the original body, resulting in a genetically human organism functioning at the sensorimotor but not cognitive level and no longer the original person's body, i.e., a substantial change to a "humanoid animal" (the term being intended in a philosophically technical, not pejorative, sense). This mindless animal-level body would seem to be physiologically and psychologically identical to a severely demented person, but is not a demented Smith, because Smith is over there in the association cortex. I did not give much importance to this stage of the experiment, because of its highly speculative physiological basis, its extremely science-fictionesque character, and its impossibility of application to real demented patients without grave moral risk. I mentioned it briefly, only for the sake of logical completeness.

In discussing the extensions of the thought experiment in the second half of the *Thomist* article, I stressed the important distinction between metaphysical, ethical, and public policy considerations. Even if the metaphysical analysis of "neocortical death," for example, were in principle correct, that *per se* would by no means legitimize in practice the wanton killing of these bodies, their use for medical experimentation, etc. The reasons were multiple, including diagnostic uncertainty, the likelihood of abuse, and the serious scandal to the great majority who would not understand such subtle neurological and philosophical distinctions and who would misinterpret such actions as societally sanctioned attacks against innocent disabled human beings. (Such concerns seemed considerably less with respect to treating "whole-brain dead" patients as dead.)

I also took pains to dissociate this conclusion from the nefarious concept of "brain life" or "brain birth," a purported mirror image of "brain death" which a few years later would gain popularity as a justification for abortion and human embryo experimentation [Beller and Reeve 1989; Jones 1989; Sass 1989]. I pointed out that the embryo does not need a functioning brain to be a living human being. Its dynamic unity derives not from a central coordinating organ but from the mutual interaction among all its constituent parts. The thought experiment and its conclusions simply did not apply to developing embryos, but rather to mature mammalian organisms that by nature depend on highly developed central nervous systems [cf. Grisez and Boyle 1979].

These, then, were the main ideas that appeared in the January 1985 issue of *The Thomist*. Soon afterwards I received a couple of letters from readers, praising the article for its clarity, breadth and coherence. It seemed to have accomplished its purpose of synthesizing the philosophical and medical aspects of death and of putting life-respecting consciences at ease regarding discontinuing ventilators and harvesting organs from "brain-dead" patients.

C. A clinical-ethical interlude – the calm before the storm

The metaphysical question having been laid to rest (so it seemed), I proceeded

to focus on the more clinical aspects of "brain death," particularly diagnostic accuracy and the establishment of diagnostic criteria applicable to children. In 1984 I was appointed to the newly formed Ethics Committee of the Child Neurology Society (CNS), one of whose charges was to make recommendations concerning "brain death" in infants and young children. (Children under 5 years old were specifically excluded by the President's Commission criteria [President's Commission 1981 (p. 166)].)

The Ethics Committee preliminarily opined that the overall diagnostic approach of the President's Commission was basically valid also for young children (but not neonates), except that longer observation periods and more confirmatory tests would be required (details unspecified). The Committee also recommended that a multi-institutional study be undertaken to develop and validate more specific criteria for different age groups. In mid-1985 a Multi-Society Task Force was constituted to draft a quasi-official set of diagnostic guidelines, which eventually would take the form of an algorithm of age-dependent variations on the President's Commission criteria. As a member of the CNS Ethics Committee, I was asked periodically for feedback on the work of the Task Force and on the planning of the multi-institutional study (which never took place).

In pondering how to design such a study with sufficient statistical power to validate a "brain-death" criterion, I realized that the ethical issues surrounding the diagnosis created unique methodological challenges. Everyone agreed that diagnostic criteria for death should be morally certain, i.e., have a virtually infinitesimal risk of false positive error (mistaking a live patient as dead), with as small a risk of false negative error (mistaking a dead patient as alive) as possible within the former requirement. All the standard criteria were (and still are) of the form "absence of such-and-such neurologic functions for such-and-such a period of time," plus or minus such-and-such "confirmatory" tests (typically optional and not necessarily even truly "confirmatory" [cf. Shewmon 1994]). One thing clear was that no set of diagnostic criteria, including those of the President's Commission, had ever been empirically validated with statistical rigor, and it was of no little concern to me that diagnoses of death were routinely being made on the basis of unproved standards.

While considering the requisite methodology for such validation, I was surprised in the spring of 1986 to come up with a mathematical proof of its practical impossibility. Basically, I showed that to establish that a given set of criteria for "brain death" entailed a negligible risk of false positive error (*however* one cared to quantitate "negligible" mathematically) would require a study population orders of magnitude greater than the largest conceivable realistic study [Shewmon 1987c]. Moreover, the requisite "observation time" turned out to be many-fold longer than what would be useful for organ transplantation [Shewmon 1987d]. The only way around these statistical obstacles was to find *self-evidently valid* criteria upon which to base the diagnosis, such as neuroimaging or blood-flow evidence that total brain infarction had occurred,[e] or a pathognomonic sequence of clinical signs (in an appropriate etiological context) indicative of completed rostro-caudal brain herniation (see Shewmon

[1994] for a fuller explanation).[f]

It seemed to me that, if the standard criteria for adults and older children were not only unvalidated but intrinsically unvalidatable, their extension to the immature nervous system was empirically groundless and ethically precarious. I brought these considerations to the Task Force's attention, but, as I was a clinician and not a statistician, and as the proof had not yet been accepted for publication in a peer-reviewed journal, my concerns fell on deaf ears. Despite its timeliness and potential import, an abstract of this work was even rejected by the Program Committee for the CNS's October 1986 annual meeting. By the time it gained credibility by publication as the lead article in a medical statistics journal in the summer of 1987 [Shewmon 1987c], it was too late to have had any impact on infant "brain-death" criteria. Between June and August of that same year, the Task Force's "Guidelines" were published in parallel in five major journals [Task Force 1987]. The most I could do at that point was to write a brief critique, which, after 17 months of editorial deliberation and revision, finally appeared as a letter to the editor in December of the following year [Shewmon 1988c], along with a rather anemic response by the Task Force [1988]. (During the interim I also had a couple of letters to the editor published reflecting the same concerns as applied to specific articles of others [Shewmon 1987f, 1988d]. The statistics article also provided a solid point of departure for two pieces on coma prognosis [DeGiorgio and Shewmon 1989; Shewmon and DeGiorgio 1989].)

In the summer of 1986, I was invited to write a chapter on infant "brain death" for a forthcoming book on medical ethics. Reflecting the above concerns, I entitled it "Caution in the definition and diagnosis of infant brain death" [Shewmon 1988b]. The chapter began with a brief synopsis of the equivalence of "brain death" with death, making use of the thought experiment but stressing that, although I saw merit to the notion of "neocortical death" *in theory* (referring to the *Thomist* paper), I opposed its implementation *in practice*, for it would only lead to scandal and abuses [Shewmon 1988b (p. 42)]. I then discussed the medical aspects, focusing on developmental factors that create unique problems for diagnosing total infarction of the immature brain, over and above the intrinsic unvalidatability of "brain-death" criteria in general.

Quite another reason for caution had also arisen. In the fall of 1986, a California senator proposed a bill (SB 2018) to define anencephalic infants as *ipso facto* "dead," in order to legitimize harvesting their organs while still breathing and moving. The stated rationale was that these biologically live newborns were "brain absent" (even though really only "cerebral hemisphere absent") and therefore equivalent to "brain dead." Such a misunderstanding of "brain death" was not surprising on the part of a politician, but it echoed a current of thought within medicine that rapidly became a tidal wave sweeping across the whole country, a wave of utilitarian depreciation of the lives of the most severely disabled, justified by a cacophony of inconclusive and even contradictory medico-philosophical assertions. The anencephalic issue revealed more alarmingly than ever the breadth and depth of confusion among health professionals regarding the essence of "brain death" and the reasons for its purported equivalence with death – confusion latent under the appearance of

consensus, which was proving to be one merely of practice, words, and explanatory clichés, not of understanding.

I was less concerned about a brief shortening of the lives of a few anencephalic infants than about the more far-reaching consequences of such a volatile combination of utilitarian motivation and incoherent reasoning. The anencephalic issue was clearly but one prong of a progressive assault on the traditional Judaeo-Christian ethic by what would later come to be denoted the "culture of death" [___ 1970; John Paul II 1995]. In October, 1986 Alexander Capron and I both testified at an open forum against the Senate bill, which fortunately died in committee. The following year I co-authored an invited editorial on the subject in the *Los Angeles Times* [Rothenberg and Shewmon 1987] and began to be invited with increasing frequency on the lecture circuit.

Subsequently I wrote an article for the *Hastings Center Report* about the medical aspects of anencephaly, emphasizing certain under-appreciated facts that contradicted the typically cited rationales for proposing to define these infants as "dead" [Shewmon 1988a]. This provided the raw material for another article eventually published by the *Journal of the American Medical Association*, co-authored with Mr. Capron and two colleagues at UCLA, presenting both ethical and practical reasons against singling out anencephalics as exceptions to either "brain death" criteria or the "dead donor rule" of organ transplantation [Shewmon et al 1989]. Although submitted in September 1987, the manuscript was severely delayed in the journal's peer review process, mainly on account of reviewer opposition to its ethically conservative stance, so that the final revision did not actually appear in print until March 1989.

On a parallel front, I was becoming increasingly caught up in the battle against euthanasia. In May 1986 I squared off against Derek Humphry, executive director of the Hemlock Society (a euthanasia advocacy group), before the California Medical Association's Committee on Evolving Trends in Society Affecting Life. (The Committee maintained its formal position against euthanasia.) In 1987 I also debated euthanasia advocates on various TV and radio talk shows, testified at a California Senate Judiciary Committee meeting against euthanasic withdrawal of artificially administered nutrition and hydration (SB 1595), spoke at a meeting of the U.S. Catholic Bishops on the growing importance of the euthanasia issue, and wrote a couple of articles against euthanasia [Shewmon 1987e, 1988e]. The year 1988 witnessed even more activity in this direction, occasioned by the euthanasia initiative scheduled for the California state ballot that fall.

D. Delayed reactions to the Thomist *article*

These mid-'80s efforts to promote the sanctity of life are mentioned here as a backdrop against which the irony of the following events stands out. In late December 1986, a priest friend brought to my attention an article entitled "Why I am uneasy about the right-to-die debate," which appeared in the clerical magazine *The Priest* [Barry 1986]. The author, Fr. Robert Barry, known for orthodoxy and pro-life advocacy, presented some cogent parallels between certain trends in contemporary medicine – such as the withdrawal of tube feedings

from PVS and other severely incapacitated patients, the nontreatment of disabled newborns, the practice of active euthanasia in Holland and its growing promotion in the U.S. – and the so-called "euthanasia" program of Nazi Germany. So far, so good – until I came to two paragraphs comparing me by name with Karl Binding and Alfred Hoche, whose 1920 book advocating the destruction of "life unworthy of life" has already been mentioned above – a parallel surmised from my *Thomist* article, particularly the section on "neocortical death."

Immediately I wrote a response which I hoped would clarify the difference between an intellectual quest for the metaphysical nature of certain kinds of brain lesions and practical advocacy of euthanasia or utilitarian murder. But before it appeared in print five months later [Shewmon 1987a], someone sent me another article by Fr. Barry (this time in a philosophy journal) which was devoted entirely to a vehement attack against the *Thomist* article [Barry 1987]. It seemed an all-out declaration of war, to which I responded in kind with a vigorous and detailed defense that proved to be the final word on this literary front [Shewmon 1987b]. Happily, we later had occasion to meet and to become reconciled on the personal level, although we continued to disagree respectfully on the nature of "brain death."

I sent all these articles to Cardinal Ratzinger, head of the Sacred Congregation for the Doctrine of the Faith, to inform his office of the nature of the debate and to encourage the Holy See to consider studying the matter and taking a position on "brain death." Although the Sacred Congregation did not itself take up the topic, it followed with great interest the work of the Pontifical Academy of Sciences, which had already begun a study of "brain death" in 1985 and to the second round of which (1989) I would be invited. But that is getting ahead of the story.

Just as the controversy seemed to have had subsided, in December 1987 Prof. Josef Seifert, rector of the Internationale Akademie für Philosophie in Liechtenstein, sent me a manuscript of his in press about abortion and euthanasia [Seifert 1987] along with a cordial letter inviting dialogue. The part about euthanasia dealt extensively with the issue of "brain death" and cited my *Thomist* article heavily. He argued energetically that neither "neocortical death" nor "brain-stem death" nor even "whole-brain death" was truly death, and that therefore the transplantation of vital organs from "brain-dead" donors was gravely immoral. Although he strongly disagreed with me and at one place even accused me of feeling "entitled to inflict the excruciating death of starvation and dehydration to such new *Untermenschen* or hopeless cases" (p. 173), many of his points were cogent and intriguing. I therefore replied, and a respectful though initially wary epistolary relationship commenced.

One of his criticisms, which I rejected at the time, was that my analysis rested on the fallacy of what he called *"actualism,"* by which the person is reduced to his or her acts. I agreed completely that the mere inability to think or sense or exercise volition on account of a brain lesion does not *per se* imply nonexistence of the person. I was confident that the thought-experiment approach was not founded on that error, because, if the hypothetical experiment would really produce two living organisms only one of which was the original person, there

was nothing "actualistic" in concluding that the other organism was *not* the original person. Nevertheless, with respect to the *real clinical context* of dementia – i.e., a gradual degeneration of the brain *in situ* – I could not help agreeing at least subliminally that it did sound a lot like actualism to assert that the loss of cognitive functions equaled loss of the person. Because the thought experiment seemed logically watertight, however, my intellectual course was not deflected by Seifert's arguments.

IV. Re-examining the cortical basis of consciousness

A. Consciousness in hydranencephaly

Then one fateful day in July 1989, a friend asked my opinion about a human-interest story he had clipped from a newspaper, entitled "Boy born 'brainless' fools doctors. Andrew celebrates happy 5th birthday" [Baskerville 1989a]. Given the *National Enquirer*-style headline, I read with incredulity about this boy with hydranencephaly who was described as conscious, adaptively interactive with the environment and quite sociable. I knew for a "fact" that, due to the total absence of cerebral cortex (in the presence of an intact brain stem), hydranencephalic children are necessarily in a permanent vegetative state. I therefore said this was nonsense: typical sensationalistic journalism. Either the diagnosis was wrong or the mother and/or reporter was exaggerating. Not long afterwards, however, someone from a different city sent me a similar article about the same boy [Baskerville 1989b]. I therefore decided that the story warranted at least a quick investigation.

As the articles mentioned the adoptive mother's name and city, I was able to track her down through telephone information. After an introductory conversation, she verified all the claims of the articles and even more. For example, Andrew could scoot around the house on his back by pushing with his legs, without bumping into furniture; during the summer he would scoot through open doors onto the sun porch. He was obviously not only conscious but had at least rudimentary vision and voluntary motor functions.

Moreover, his remarkable mother, a former pediatric nurse, had lovingly adopted not one, but three children with hydranencephaly. One was still too young to manifest any unusual abilities, but the other was a twelve-year old girl who was also described as definitely conscious. Although she had less vision than her five-year old brother, she was more discriminating between familiar people and strangers based on auditory, tactile and perhaps olfactory cues. Both children had favorite pieces of music and reacted appropriately to musical moods through facial expressions, vocalizations and bodily movements. Their mother took understandable pride in recounting their various cognitive abilities and sensorimotor functions, which doctors had repeatedly guaranteed could not possibly develop.

Any lingering doubts in my mind were dispelled upon learning that their pediatric neurologist was my esteemed colleague at Boston Children's Hospital, Dr. Gregory Holmes, whom I immediately called with mother's permission and who confirmed both the diagnosis of hydranencephaly and everything she had said about the children's abilities. I was in a state of shock, amazed that a medical "fact" so certain as the necessity of the cortex for consciousness was evidently not true in

all cases. It takes only one exception to disprove a universal rule, and here were two!

Why did such outcomes not occur more often in cases of hydranencephaly? Most likely, I suspected, because the prognosis of vegetative state universally told to parents tends to become a self-fulfilling prophecy. These two children were given constant, loving nurturing, in contrast to most hydranencephalics, who are typically placed in a corner and only intermittently and perfunctorily attended to. Even neurologically normal infants, if neglected and emotionally deprived, will fail to develop, especially in the area of social relatedness. Should it be surprising, therefore, that severely disabled newborns might never develop beyond a vegetative state if they are perceived and treated from the start as mere "vegetables"?

The discovery was so monumental for me that the following year I made a special trip to see the children in person, which proved to be both confirmatory and moving. I was joined by pediatrician and "brain-death" critic Dr. Paul Byrne, with whom I had already developed a friendly relationship despite our differences of opinion and who had also previously witnessed the children's cognitive abilities. Subsequently Dr. Holmes and I reported the two cases in an abstract for the 1990 Tokyo meeting of the International Child Neurology Association, speculating that in the congenital absence of cortex, developmental plasticity may allow the brain stem to assume certain otherwise "cortical" functions [Shewmon and Holmes 1990].[g]

B. Rethinking PVS – "absence of evidence" is not "evidence of absence"

The two hydranencephalic children impacted my thinking at a propitious moment. By this time the focus of attention in bioethics circles had progressed from "brain death" to persistent vegetative state. Through the decade of the '80s, court cases involving termination of tube feedings for PVS patients had proliferated like wildfire. In 1981 the AMA's Judicial Council declared it ethical to discontinue all means of life support "where a terminally ill patient's coma is beyond doubt irreversible" [American Medical Association 1981 (p. 9, par. 2.11)]. (By 1986 the phrase "terminally ill" was dropped from this section of the code of ethics [American Medical Association 1986 (pp. 12-13, par. 2.18)].) The 1983 President's Commission addressed this subject in its large and influential monograph *"Foregoing Life-Sustaining Treatment,"* concluding that treatment decisions in PVS were best left in the hands of patients' surrogates, not of the courts, and that discontinuation of all treatment, including artificially administered nutrition and hydration, was a legitimate option [President's Commission 1983 (pp. 171-196)]. Additional ethical guidelines and policy statements favoring the discontinuation of tube feedings for PVS patients were published by the Hastings Center [1987], American Academy of Neurology [1989], and the American Medical Association [1990]. Within theological circles debate raged whether the withdrawal of tube feedings in this context constituted a legitimate foregoing of "disproportionate" ("extraordinary") means or euthanasia by omission [Catholic Bishops of Maryland 1993; Catholic Bishops of Oregon and Washington 1991; Catholic Bishops of Pennsylvania 1992; Catholic

Bishops of Texas 1990; Grisez 1989; May et al 1987; National Conference of Catholic Bishops 1992; O'Rourke 1989; Paris and McCormick 1987].

By the late 1980s the medical, legal and bioethical literature had become supersaturated with the artificial hydration and nutrition issue. Despite the great variety of opinions expressed, all concurred in accepting as an undisputed factual premise that patients with widespread cortical damage are *ipso facto* unconscious and incapable of experiencing pain and suffering: that their primitive movements, facial expressions and vocalizations are mere automatic reflexes. Why? Because official neurology said so.

The hydranencephalic children proved that the cortical doctrine of consciousness was simply not true in congenital situations. Nevertheless, these cases, important as they were for pediatric neurology, did not necessarily threaten the cortical dogma as applied to older children and adults, because presumably this unique "exception to the rule" was based on the developmental plasticity of the immature nervous system. (This was, in fact, the nearly universal reaction when I later presented the cases at a seminar on "Ethical Dilemmas" at the 1992 meeting of the American Academy of Neurology.) Still, I could not help wondering: if we could all have been wrong about so certain a "fact" in the congenital case, what was the guarantee that we might not also be wrong about the same "fact" in the adult case? What was the empirical evidence that in adults all content of consciousness resides in the cortex and that without cortex there can be no consciousness of any sort?

All major discoveries in medicine – such as the circulation of blood, the germ theory of infectious diseases, the role of the brain in epileptic seizures, etc. – can be traced back to some seminal case, experiment or observation. I therefore went to the literature on coma and PVS, expecting to trace the bibliographical tree back to its historical trunk, i.e., a key article or set of articles definitively establishing the cortical basis of consciousness. Surprisingly, I soon realized that I was on a wild goose chase. No such case, study, or article existed. Rather, a variety of speculations on the neuroanatomical localization of consciousness were batted around during the mid-1900s, and then during the 1970s the cortical theory began to be repeated long enough and loudly enough by prestigious enough experts that it eventually came to be taken for granted by everyone else as an established fact.

Upon critical examination, the "evidence" turned out to be of an exclusively *negative* nature: patients with diffuse cortical destruction do not *manifest* clinical signs of awareness of self or environment. But there was no *positive* evidence that such patients are not inwardly conscious. Moreover, it occurred to me that in the context of such a lesion an empirical demonstration of absence of subjective consciousness is *inherently impossible,* even if that were the case. Diffuse cortical destruction results in spastic quadriplegia and pseudobulbar palsy, apraxia of whatever little motor control remains, global aphasia, dementia, cortical blindness, etc. How could anyone with such a disability possibly externally manifest inner consciousness convincingly, even if it were present? Furthermore, anyone aware of him- or herself being in such a state (and perhaps aware of being considered a "vegetable" by caregivers) would probably also be significantly

depressed, impairing the motivation even to attempt to communicate.

Neurologists (and everyone else) had fallen obliviously into the logical fallacy that mere *absence of evidence* constitutes *evidence of absence*. No one seemed to be concerned that perhaps what is eliminated by cortical destruction might be the *capacity for external manifestation* of consciousness rather than consciousness itself – in other words, that what is called "PVS" might in reality be merely a "super-locked-in" state.[h] This was a plausible explanatory alternative, and the scientific method required systematically ruling it out before declaring the cortical hypothesis proven. This had never been done, nor (by the very nature of the problem) could it ever be done.

But the more I reconsidered the matter, the more I began to realize that the supposed lack of evidence for consciousness was not even *complete.* For example, all treatises on the neurophysiology of pain traced the anatomical pathway from the cutaneous nociceptors centrally, invariably ending not at the cortex but at the thalamus. Patients with strokes involving somatosensory cortex lose tactile discrimination and joint position sense, but *not* the capacity to perceive and to localize pain. Neither is there any cortical region stimulation of which produces a subjective sensation of pain. Thalamic injury, however, can cause a distressing form of central pain. In the *pain literature* it is clear that the cortex's role in pain perception is merely modulatory and that the experience is mediated subcortically, but in the *PVS literature* these well known phenomena are systematically ignored. PVS patients often grimace to noxious stimuli and manifest primitive withdrawal responses. Advocates of the cortical theory write off such behaviors as mere brain-stem or spinal reflexes, but that dismissive attitude is based more on an *a priori* assumption than a scientific conclusion.

Also, there are certain visceral sensations that seem to have no cortical representation (at least they are not abolished by any cortical lesion nor elicitable by any cortical stimulation), including hunger, thirst, nausea, satiety, visceral pain, and so on. How then can one conclude that diffuse cortical destruction abolishes the capacity to experiencing such things?

The two hydranencephalic children, therefore, not only forced me to reject the cortical dogma in congenital cases; they catalyzed a critical re-evaluation of everything I had been taught on the neural basis of consciousness. And I had to admit that not only was there no direct evidence establishing the cortical doctrine, but what indirect evidence there was actually undermined it.

C. From "neocortical death" to "whole-brain death" – Pontifical Academy of Sciences, 1989

Shortly after this major reorientation, I was invited by the Pontifical Academy of Sciences to participate in its second multidisciplinary Working Group on the Determination of Brain Death and its Relationship to Human Death, which convened at the Vatican on December 10-14, 1989. What I proposed there was similar to before, but without the cortical extension. The "whole-brain" version of the thought experiment still seemed valid: the person surely dies when the isolated living brain dies, not when the brainless body succumbs to cardiac arrest. Death could be confidently equated with death of the "brain as a whole," on the

basis that the brain as a whole is *both* integrator of the body *and* mediator of consciousness. Since death of the "brain as a whole" clearly does not require destruction of every single neuron (no more than death of the body requires destruction of every cell), and since neither cortical destruction alone nor brain-stem destruction alone sufficed, I proposed that the minimum subset of brain destruction sufficient for death (the "physiological kernel" of death) was the combination of brain-stem reticular formation, diencephalon and cortex. I also emphasized how semantic ambiguities and conceptual fallacies unfortunately permeated the "brain-death" literature and carried potentially serious moral consequences, but that, nevertheless, a coherent brain-based formulation of death could still be compellingly built on firm logical and neurophysiological grounds [Shewmon 1992].

My equating of death with "whole-brain death" was now much more in the mainstream, reflecting especially the line of thought of Bernat [1984, 1991, 1992, 1994], Ingvar [1986; Ingvar and Bergentz 1992] and the Swedish Committee [1984], and the Pontifical Academy of Sciences' previous Working Group of 1985 [Chagas 1986 (pp. 113-114)], the consensus statement of which was basically ratified and further expounded in the medical consensus statement of our 1989 Working Group [White et al 1992]. A lone dissenter was Professor Seifert [1992], whom I met face to face for the first time and who could rejoice, if over nothing else, at least over my recent abandonment of "neocortical death."

On the morning of the final session, our group was graced with a visit from Cardinal Ratzinger and a special audience with his holiness Pope John Paul II, both of whom were keenly interested in the topic and conclusions of the Working Group. The Holy Father reiterated the Church's moral teaching concerning, on the one hand, the laudable charity of life-giving organ donation, and on the other hand, the absolute prohibition against direct killing and therefore the importance of ascertaining with moral certainty the donor's death prior to explantation of vital organs.[i] Significantly, he left completely untouched the key question, namely, whether "brain death" could be regarded with moral certainty as death [John Paul II 1989].

I had the unexpected good fortune to greet the Holy Father a second time that same day, after a mass he celebrated for university people. When I reminded him that we had just met that morning with the Working Group on "Brain Death," he kindly thanked me for my participation and said that the topic of our study was "very important;" then, after a brief and pregnant pause, he added with profound solemnity, "and very difficult." I shall never forget that phrase and the aura of timeless wisdom which emanated as he uttered it. It was as though he had condensed into those three words something to the effect: "I sincerely appreciate the effort and good will of all of you in placing your expertise at the service of the Church. But don't forget that the history of natural science has shown repeatedly that the consensus of experts at a given moment can be thoroughly mistaken. Even though you are all quite certain of your conclusion, the Church is not about to take any official position on 'brain death.' Please keep up your study in a spirit of humble search for the truth, and

may God bless you."

V. Re-examining the "central integrator" theory

A. Seeds of doubt

This brief encounter with the Holy Father made a powerful impact and left me wondering: if I recently changed my previously "certain" opinion about "neocortical death," how can I be sure that I am presently right about "whole-brain death"? What if I, along with the great consensus of experts, have been overlooking some critical contravening consideration? Can I be *morally certain* that "brain death" is death, especially given that a small minority of intelligent and knowledgeable individuals, such as Jonas, Quay, Byrne, and Seifert, disagree despite having examined the same evidence? That is, can I be morally certain enough to risk the direct killing of heart donors if I am wrong? Phrased this way, it was a disturbing question for which I had no ready answer.

Moreover, there was one aspect of my new synthesis with which I was still not entirely satisfied. I had proposed to the Working Group the following line of reasoning: (1) According to Aristotelian-Thomistic metaphysics, substantial change (in general) takes place when accidental changes reach a critical state of incompatibility with the substantial form (essence) of the original substance; in the case at hand, human death occurs when pathologic processes render the body no longer compatible with the human essence. (2) The human essence (human substantial form, human personhood) is not dissociable from the biological human organism; to hold the contrary would be to fall into either "actualism" (admitting the possibility of a genetically human body lacking the human essence on the basis of incapacity for specifically human acts) or Cartesian dualism (equating the human essence with a purely spiritual mind intrinsically unrelated to the animal-body). (3) Therefore, the concept of human death necessarily entails *both* loss of somatic integrative unity *and* loss of the human essence (i.e., of essential human properties). If in a given case the two aspects seem to have become dissociated, one would have to question seriously whether death had truly yet occurred. Otherwise, one would have to speak of an unconscious, integrated, obviously living human body as "dead" (on the basis of having lost "personhood"), or else to speak of a conscious person with a "dis-integrated" body as "dead." Neither alternative made much sense.

In the paper for the Pontifical Academy, therefore, I took it as axiomatic that any valid criterion for death had to encompass both aspects and that, in particular, if "whole-brain death" is to be equated with death, it should fulfill both requirements [Shewmon 1992 (p. 31)]. And so it seemed to do: a mere listing of all the known integrative functions of the brain surely sufficed to prove the loss of integrative unity in a "brain-dead" body, while the thought experiment conclusively demonstrated the loss of the human essence (i.e., loss of personhood).

This was precisely why the notion of "brain-stem death" failed: because it took into account only the integrative-unity aspect and not the essential-human-properties (personhood) aspect. I recounted the *Thomist* article's argument

against "brain-stem death," based on Hassler's stimulation procedure for restoring consciousness to patients comatose from brain-stem lesions, and how the logic of "brain-stem death" inherently implies the absurd possibility of a conscious "corpse." I also used this example to illustrate a critical distinction between what I termed "intrinsic" and "extrinsic" irreversibility of the loss of one or more brain functions. The former corresponds to physical destruction (typically infarction) of the relevant structures, while the latter corresponds to (theoretically) potentially reversible nonfunction of an intact structure (as is the case with cerebral cortical nonfunction in the face of brain-stem destruction). Only "intrinsic" irreversibility is relevant to neurologically based formulations of death.

As I was developing this argument against "brain-stem death" in the manuscript for the Academy, however, I realized that it also inchoately threatened my own axiom of convergence of the two aspects of human death. This is what I wrote:

> This [possibility of maintaining the hemispheres conscious despite a destroyed brain stem] seems to entail an inconsistency between the two fundamental approaches of integrative unity and essential properties, necessitating one of three conclusions: either (1) convergence of these two approaches should be abandoned as a fundamental axiom; or (2) the lack of integration of vital functions resulting from brain-stem destruction is of insufficient degree to constitute true bodily disunity and death; or (3) isolated brain-stem destruction reduces the body (in the technical philosophical sense) to the cerebral hemispheres.
>
> The first solution threatens the very foundations of metaphysical realism, which in my opinion should be taken as more self-evident and inviolable than any secondary conclusions about the neurological core of death. The second undermines 'whole-brain death' as much as it does 'brain-stem death' and seems counterintuitive in light of the considerations in section V.B.1. [regarding the integrative functions mediated by the brain]. The third solution, by default, is what I tend to favor. [Shewmon 1992 (p. 39)]

Evidently, I was not particularly happy with this "third solution" but felt forced to accept it reluctantly by a process of elimination, because of the presumed unassailability of both the "dual aspect" axiom and the central integrator theory.

As time passed, my dissatisfaction with this analysis kept bothering me. At first it was merely a subliminal sense that a potential objection to my thesis had not been put to rest prophylactically with sufficient thoroughness. I did not give it much importance, because I was sure that whenever the issue would have to be dealt with in the next manuscript on "brain death," a convincing justification for the "third solution" (in its own right, and not merely "by default") would be forthcoming. I gradually began to realize, however, that its justification was more elusive than I had assumed, and that insistence on preserving the link between "essential human properties" and somatic integrative unity in this hypothetical scenario really might be threatening the central integrator theory and with it the entire notion of "brain death."

Moreover, the following line of reasoning seemed to follow from the "second solution," if that were adopted in place of the third. *If* we were to conclude that "brain-stem death" is not death on the basis of loss of somatic integrative unity, then neither is "whole-brain death" death on that basis; but if the link between the

two aspects is to be preserved, then neither would "whole-brain death" entail the loss of essential properties. This would imply that the subjective consciousness, the intellectual functioning and the volition lost with "brain death" are not "essential human properties" after all, at least in any sense relevant to substantial change from life to death. This latter consequence did not even occur to me at the time, but it seems clear now, and I shall return to it below (at the end of section VI.B.). In retrospect, the phrase "essential human properties" can be understood in two ways, and I was caught up in an equivocation between them. In any case, what was clear was that many conceptual dominoes would fall if the "third solution" were to be rejected.

B. Natural simulation of the thought experiment: functional disconnection of the brain – Rome, 1992

While still grappling with this problem, I was invited back to Rome to present a paper on the clinical diagnosis of death in infants and children at an international conference on Care for the Dying Person sponsored by the Center for Bioethics of the Catholic University of the Sacred Heart, March 15-18, 1992 [Shewmon 1994]. My emphasis was on the importance of moral certainty in the neurological diagnosis of death, and on a clinical approach that would render negligible the risk of false positive error (declaring a live person dead) while minimizing to the extent possible the probability of the less egregious false negative error (declaring a dead person alive).

Although the paper's focus was clinical and diagnostic rather than conceptual, in the introduction I dared to articulate – at the risk of sawing off the limb I was sitting on – the concern obliquely intimated to me by the pope two-and-a-half years earlier, namely the issue of probability of *conceptual* false positive error. What good is moral certainty of the clinical diagnosis of total brain infarction, if there is a nonnegligible risk that this state might not represent death? What is the probability that the strong consensus about "whole-brain death" is wrong? It cannot be mathematically zero, given that *some* intelligent experts continue to reject the "party line," but are they few enough and their arguments inconsequential enough that the probability of conceptual false positive error could be regarded as at least morally negligible? Here is what I wrote:

> It seems unclear, therefore, how to evaluate the magnitude of the risk of false positive conceptual error, at least to the extent of determining whether it is large enough to be morally relevant. As is clear from the history of science (especially medicine), neither does complete unanimity guarantee truth, nor does incomplete consensus necessarily imply an inherent inconclusiveness of the evidence or an impossibility of achieving subjective moral certitude. Personally, I am convinced that many of those who hold inconsistent views on 'brain death' do so primarily out of lack of sufficient study of the issue. I have found the *combined* arguments of loss of somatic unity and loss of essential human properties compelling reasons to accept the equivalence between total brain destruction and death; conversely, the standard arguments against such equivalence often appear to be based on a latent Cartesian dualism and a lack of understanding of neurophysiology.
>
> It would seem that no more can be demanded of one than to act in consequence with a well informed conscience. Where there is a large consensus of moral certainty among true experts, it seems perfectly appropriate for society to recognize neurologically based diagnoses of death. By contrast, in societies where this remains a source of major

> controversy (e.g., Japan and Denmark), it seems also appropriate for them to continue banning vital-organ transplantation until a stronger agreement on the fundamental concept of death can be reached.
>
> The importance that one's conscience be *well-informed* cannot be overemphasized....
>
> This *caveat* having been made, let us assume for the sake of argument that a neurological essence of death is morally certain conceptually, and move on now to consider various practical sources of false positive diagnostic error and how to eliminate them. [Shewmon 1994 (pp. 144-145)]

This was the best response I could generate to my own rhetorical question, and I was inwardly not very satisfied with it. It really seemed to dodge the issue, merely substituting cultural relativism and majority opinion for moral certainty. The dissatisfaction was only heightened by my inability after nearly three years to find an adequate way around the hypothetical "conscious corpse" anomaly deriving from electrical stimulation of the cerebral hemispheres in the context of brain-stem destruction and its supposedly attendant loss of somatic integrative unity. Although my talk was well received, I was disquieted. Had I really pulled the conceptual rug out from under myself? Could I in good conscience continue to preach the importance of accuracy in the clinical diagnosis of a condition that I could not honestly admit to myself had true moral certainty of equivalence with death?

I therefore took advantage of the conference's location to visit the magnificent Blessed Sacrament chapel in St. Peter's basilica to pray at length on this whole matter, sincerely begging for light. What I so greatly needed was some sort of empirical evidence as relevant to the brain-as-central-integrator-of-the-body theory as the encounter with the hydranencephalic children was to the cortex-consciousness theory. The answer was not long in coming. After a few minutes of recollection, the following thought suddenly entered my mind from out of nowhere, with the clarity of the midday sun.

Suppose there were some disease or pathology that *functionally* disconnected the entire brain from the rest of the body, i.e., an experiment of nature simulating the *structural* disconnection of the thought experiment. Would that patient's body, in the absence of the central integrating influence of the brain, become merely a collection of organs, while his or her *real* "body" (in the technical, philosophical sense) had become reduced to the conscious brain only? If the answer were "yes," then somatic integrative unity would be irrelevant to the essence of human death. If the answer were "no," then the brain would not constitute the "central integrator" of the body after all.

Well, there *are* such diseases and pathologies. One example is a high cervical cord transection (for the sake of completeness, imagine it combined with bilateral vagotomy and hypothalamic hypopituitarism).[j] An even more interesting example is Guillain-Barré Syndrome (acute inflammatory demyelinating polyneuritis), which can affect both spinal and cranial nerves, segmental and autonomic [Ropper 1993]. In its most severe form no information can enter or leave the central nervous system, creating a total locked-in syndrome externally mimicking "brain death" [Carroll and Mastaglia 1979; Drury et al 1987; Kotsoris et al 1984; Langendorf et al 1986]. Such patients appear completely comatose, even though they have essentially normal electroencephalograms and

are quite conscious inwardly. With the passage of time the inflammation subsides, and they recover strength and sensation to varying degrees.

During the peak of the illness, these patients require technological assistance with breathing, blood pressure regulation, fluids and nutrition, electrolyte balance, and so on. To make the functional equivalence with "brain death" complete, suppose that such a patient also had hypothalamic hypopituitarism and required replacement therapy for some pituitary hormones. An intensivist caring for such a patient would hardly regard his or her work as futile treatment being wasted on a corpse. Nevertheless, that patient's body completely lacks the integrating influence of the brain to the same extent as a "brain-dead" body. Nay, more: it is even without the integrating influence of the spinal cord as well, yet nevertheless obviously alive.

Evidently, the brain is *not* the "central integrator" of the body after all. As I considered the profound implications for "brain death" of severe Guillain-Barré Syndrome and other functional brain-body disconnections, it also dawned on me that the somatic integrative functions that do *not* depend on the brain are actually considerably greater in number than those that do.[k] In fact, the integrative functions that are replaced technologically in the intensive care unit for both severe Guillain-Barré and "brain dead" patients are relatively few: a machine does the work of the diaphragm and intercostal muscles (not even an "integrative function," strictly speaking), fluids and nourishment are provided intravenously (sometimes even nasogastrically), various drugs may be administered to maintain blood pressure and fluid balance (not always even needed), the patient is turned to prevent bed sores and suctioned to prevent pneumonia. This is not an inordinate amount of substitutive technology for modern hospital standards; in fact, it is considerably less than that required by many patients in intensive-care units who are still, despite all their dependence on technology, quite alive.

Everything else the body does for itself. The heart beats spontaneously and the lungs exchange oxygen and carbon dioxide as usual. If the spinal cord is intact (as is often the case in "brain death"), the preganglionic neurons in the intermediolateral cell column can provide sufficient sympathetic vascular tone to maintain blood pressure spontaneously without pharmacologic assistance. If the gastrointestinal tract is motile (although in many cases of "brain death" it is not), food placed through a nasogastric tube will be digested; otherwise, parenteral administration of fluids and nutrition is required. In either case, the spontaneously circulating blood distributes nutrients throughout the body, where cells assimilate them for energy, growth and repair; simultaneously the same circulating blood carries off metabolic wastes produced by the cells. The liver detoxifies the blood and keeps the body in an incredibly complex chemical homeostatic balance, while the kidneys maintain the body's fluid and electrolyte balance (perhaps with the help of DDAVP or vasopressin). The immune system recognizes foreign bodies and fights infections. Wounds heal. Many endocrine functions continue independently of the hypothalamus. Even a "brain-dead" pregnant body can gestate a fetus [Bernstein et al 1989; Dillon et al 1982; Field et al 1988; Heikkinen et al 1985].

To speak accurately, then, it would seem that the brain's role *vis a vis* somatic

integration is more one of *modulating and fine-tuning* a structurally and metabolically unified body than of *constituting* a "central integrator" without which the body lacks unity and ceases to be a body. Not all biological integration requires an *integrating organ*, as plants and embryos notably demonstrate; integration can consist simply in the mutual interaction among multiple tissues and organ systems. Thus, I was forced to admit that perhaps a "brain-dead" body was not dead after all, but rather alive and in a deep and permanent coma and highly prone to die without technological assistance. Perhaps Jonas, Byrne, Seifert, and the few other voices crying in the wilderness against "brain death" were right all along!

But how was this new insight to be reconciled with the thought experiment, which seemed to prove conclusively that the person dies when the brain dies, even if the rest of the body still lives? Although the path to that reconciliation was not yet clear, one thing *was* clear: contrary to the official "party line," the integrative unity of the body does not derive from the brain and is not lost with destruction of the brain. How right the pope was: the question of the moment of death is indeed "very difficult" – much more so than I had realized at the time.

C. Another pivotal case

Upon return from Rome I decided to lay low for a while on the subject of "brain death" in order to assimilate these new insights and their ramifications. As if to seal the new conceptual orientation with empirical confirmation, a case came my way that did for integrative unity and the brain what the hydranencephalic children did for consciousness and the cortex.

An almost fourteen-year-old boy in a hospital in San Francisco had been declared "brain dead" following a head injury. After parents refused organ donation, his physicians were going to discontinue all further treatment, but the parents did not believe that he was dead and insisted on continuing intensive care, soliciting the help of a lawyer. Although the physicians would have been legally justified in disconnecting the ventilator over the parents' objection (since the boy was legally dead), they did not do so, both to avoid unpleasant confrontation and because they considered it highly probable that cardiovascular collapse would supervene imminently despite intensive care, rendering the whole issue moot. (The parents had agreed to a "do-not-resuscitate" order.)

One reason the parents did not believe he was dead was that every now and then he made a slight spontaneous movement of his shoulders, a phenomenon described in the "brain-death" literature and attributed to the spinal cord [Heytens et al 1989; Jordan et al 1985; Jørgensen 1973; Mandel et al 1982; Ropper 1984; Turmel et al 1991]. They simply could not accept that a body with a spontaneously beating heart, warm pink skin, urine output and spontaneous movement was dead. They also tended to vitalism, not drawing a distinction between morally ordinary ("proportionate") and extraordinary (disproportionate") means, believing that if God wanted to take their son, He would have done so more definitively, and that in the meantime they were obliged to do whatever they could to keep him alive.

As related to me later by the father, at one point a compromise agreement was

reached with the physicians to undertake a limited trial of minimal support in order to discover God's will in the matter. For two days the boy would receive only mechanical ventilation, routine intravenous fluids, a daily injection of DDAVP for diabetes insipidus, and basic nursing care – no pressors, antibiotics or other forms of treatment. If after two days he had not succumbed, that would be taken as a sign that God wanted treatment continued and the hospital would seek to transfer him to a chronic care facility; on the other hand, if his heart stopped, that would also be a sign of God's will. The doctors agreed, because they were confident that cardiac arrest would quickly supervene. But it did not. They kept their promise and arranged for transfer to a skilled nursing facility six weeks after the boy's head injury.

This was quite a remarkable case, because to my knowledge never before in the history of medicine had an officially dead body been transferred on a ventilator from a hospital to a nursing home. It is amazing enough that the hospital was even able to find a facility that would accept a "corpse" as a patient. Understandably, everyone at the receiving end was quite confused as to the vital status of their new resident and the therapeutic goal. As a pediatric neurologist known for interest in "brain death," I was therefore consulted.

I reviewed all the hospital records carefully, including CT scans (massive edema and herniation) and EEG reports (isoelectric on several occasions), performed a thorough general and neurologic examination, and was satisfied that the diagnosis of "brain death," in the sense of total brain infarction, was accurate.[1] Yet, here he was, receiving much less artificial support than many quite live patients in intensive care units: a mechanical ventilator, fluids and nutrition through a central venous line, a daily injection of DDAVP, and basic nursing care – that was all. Nevertheless, he seemed to be somatically thriving, showing no signs of impending decomposition. To the contrary, there were many signs of integrative unity and life at the level of the "organism as a whole." Chemical and cardiovascular homeostasis were maintained spontaneously, without pressor drugs or frequent laboratory monitoring and adjustment of intravenous fluid composition. With the help of antibiotics, he had recovered from several bouts of pneumonia. Strangely, he even began puberty (or at least adrenarche) while "brain dead," a phenomenon not previously reported in the literature. He survived with this kind of minimal support for a total of nine weeks, until succumbing to a pneumonia, which (with parents' concurrence) was not treated. Presumably he could have survived much longer, had there been a therapeutic motivation. This experience definitively removed any residual hesitation over rejecting the brain-as-central-integrator-of-the-body theory.

But if "brain death" does not entail loss of bodily unity, why are prolonged survivors such rare exceptions rather than the rule? This was a legitimate objection, prompting an investigation of as many reports as I could find of prolonged somatic survival with "brain death." I managed to collect over thirty cases, with survivals ranging from one week to 9 months, half of them over 8 weeks.[m] From the clinical details several relevant considerations emerged.

First, most of the cases (especially the more spectacular survivals) involved primary intracranial pathology, whereas the spectrum of etiologies for "brain

death" in general includes a significant proportion with diffuse systemic insult, typically from cardiopulmonary arrest or multiple trauma. Perhaps those cases that proceed inexorably to asystole within a few days despite intensive care really *are* dead, but dead by virtue of *supracritical multi-organ damage* rather than brain failure *per se*.

Second, a declaration of "brain death" strongly tends toward a self-fulfilling prophecy with respect to somatic death. If organs are donated, the body is surely dead afterwards if not before. If organ donation is not to occur, ventilatory support is typically discontinued and the body sent to the morgue. In either case, there is no opportunity to learn how long survival with intensive care might have been. The cases of prolonged survival always involved some special motivation on the part of the health-care team, typically: bringing the fetus of a pregnant "brain-dead" woman to viability, familial vitalistic insistence on treatment, or fear (whether grounded or not) of litigation. There would undoubtedly be many more cases of prolonged survival if all "brain-dead" patients were treated aggressively indefinitely. (Of course, I am hardly advocating that.)

Third, the case reports involving pregnant women typically emphasize the heroic degree of effort required by the health care team, the technological *tour de force.* Some commentators have interpreted this as evidence for lack of integrative unity in the maternal body. On closer inspection, however, such efforts are understandably greater than in the cases motivated merely by familial desire or legal fears. In the latter contexts, physicians are reluctantly treating a patient who they hope will succumb to asystole as soon as possible. With the pregnant women, by contrast, they enthusiastically try to forestall asystole as long as possible, for the sake of the baby. Not only that: they try to maintain the mother's homeostasis not merely within a range grossly compatible with her own survival, but fine-tuned so as to be constantly optimal for the developing fetus. When no obstetrical aspect is involved, the level of therapeutic effort required for survival need not be so "heroic."

Fourth, Japanese law still does not recognize "brain death" as death, and for cultural reasons physicians often try to preserve bodily life as long as possible. One Japanese study found that the mere addition of epinephrine and vasopressin to the treatment regimen increased survival times of "brain dead" patients to a mean of 23.1 days (range 9.5-54 days), compared to a mean of 24.1 hours (range 1-48 hours) for those treated with epinephrine alone [Yoshioka et al 1986]. This report is not about rare anecdotes of extraordinary cases, but about the survivability characteristic of an unselected "brain-dead" population. For such a simple treatment to make such a profound difference in survival, the underlying somatic substrate must be fairly well integrated already.

VI. "Brain death" is not death

A. Trial run – Chile, 1993

The following year provided an opportunity to "test drive" this new perspective. I was invited by the Bioethics Unit of the Pontifical Catholic

University of Chile to speak on "brain death" at an International Symposium on Bioethics in Santiago, August 18-20, 1993. Not only was the audience receptive to the message, but I was edified to learn that the sponsoring Bioethics Unit had independently arrived at the same conclusion regarding "brain death." Josef Seifert, who was also invited, was similarly edified but rejoiced even more over my abandonment of "whole-brain death," which I had intentionally kept as a surprise. I was further heartened by the acceptance (or at least non-rejection) of my arguments on the part of pediatric ethicist Dr. Norman Fost, the only other North American speaker at the conference. As if to reinforce my point, he drew attention to the fact that in the early days of transplantation vital organs were removed from "brain-dead" patients in the complete absence of any medical or societal consensus that they were really dead. I returned from the conference encouraged that I was on the right track.

B. Fine-tuning

The only significant problem remaining was the apparent paradox created by applying the new view of "brain death" to the thought experiment. If "brain death" is not death, then the brainless body of the thought experiment (physiologically identical to a "brain-dead" body) must be a living human body. But the person whose body it formerly was is now across the room in the separated living brain, to which his present body has been reduced. So whose body is the brainless living human body?

I have wrestled with this question for quite a while and still do not pretend to possess a definitive answer. There is an element of mystery about it; it is a primarily philosophical problem, highly dependent on definitions of terms and concepts, impenetrable to empirical investigation, and fortunately purely hypothetical. One thing now clear is that the apparent paradox derived largely from a confusion between two distinct questions: one concerning personal identity ("Which biologically living entity is Smith: the brain or the brainless body?") and the other concerning somatic enumeration ("How many live human bodies are there: one or two?"). To say that the separated brain is Smith, and therefore that the brainless body is not Smith, does not necessarily imply that the brainless body is not a living human body. To illustrate the point by analogy, suppose a planarian named Gertrude is bisected transaxially. To identify Gertrude with the cephalic half would not necessarily imply that the caudal half is not a living planarian. In retrospect, this was the hidden flaw, the Achilles heel, of the whole thought-experiment approach to "brain death."

But the preceding insight still does not resolve the perfectly legitimate question: If the brainless body is not Smith's, whose is it? The answer depends partly on whether its life principle has a spiritual dimension or if it does not. In the latter case, it would be (1) a living body of the species *homo sapiens* but no human person. If, on the other hand, it does possess a spiritual dimension, it would be either (2) some new (severely disabled and short-lived) person, brought into existence in a very atypical way: through *asexual* human reproduction plus the creation *ex nihilo* of a new spiritual soul by God (as perhaps occurs with human monozygotic twinning [Ashley and Moraczewski 1994; May 1996]) or (3) part

of Smith's body (now in two pieces though informed by the same soul).

The third possibility seems to me not merely counterintuitive but a contradiction in terms. The argument goes that, since the human soul is spiritual, why could not one and the same soul vivify *both* the isolated brain *and* the brainless body? Behind such a line of reasoning seems to lurk a dualistic notion of soul as a kind of reified "ghost" attached somehow to an essentially animal body: given the soul's immateriality, if it can inhabit one body, why couldn't it just as well inhabit two? If, however, one accepts the Aristotelian-Thomistic concept of soul as "life-principle" or "substantial form" of a body, then, even though the human soul has a spiritual dimension, it constitutes the principle of *physical* unity and immanent dynamism of the body. To assert that one and the same principle of somatic unity was informing two physically discrete and independent unities makes little sense.

The first and second possibilities suggest that, from Smith's perspective, the thought experiment involves not so much a removal of his brain from his body as a removal of the rest of the body from his brain; the brainless body belongs to his body no more than an amputated limb belongs to the body from which it was severed. The key difference, however, is that an amputated limb is not a living organism, whereas the brainless body is. When I first conceived the thought experiment and gave it such explanatory prominence in the *Thomist* article, I regarded the brainless body as a kind of glorified amputated limb: a collection of many living cells, organs, connective tissue, etc., temporarily mutually interacting but without true integrative unity. It took nearly twenty years to see the need to question and finally to unlearn the dogma of the "central integrating organ," the official conceptual foundation upon which the edifice of "brain death" rests.

There is obviously no way to distinguish empirically among these three possible reinterpretations of the thought experiment, and I defer this debate to those more expert in philosophy than myself.

Fortunately, however, for all practical purposes the whole issue is moot. Indeed, contrary to what I had supposed for years, the hypothetical scenario of the thought experiment is actually quite irrelevant to an understanding of real, clinical "brain death." In the real-world scenario, the brain destruction occurs *in situ,* so that the question "which of these two living entities is Smith" or the issue of possible asexual human reproduction *never arises*. There is only one living bodily person: it always was Smith and still is Smith (though now a deeply comatose and critically ill Smith). The personal identity of the non-Smith body in the thought experiment has as little relevance for "brain-dead" Smith as the identity of a bisected planarian-half has for the vital status of a neurologically injured planarian.

In summary, then, the personal identity of a brainless body probably depends critically on *the manner in which it loses the brain,* i.e., whether the brain is physically removed from it intact or is destroyed *in situ*. The former case may entail (perhaps even intractable) uncertainties surrounding identity, but not the latter case, which is the only one that really matters.[n]

Clarification also emerged surrounding the notion of "essential human properties." (Here I pick up the train of thought briefly alluded to and left

dangling at the end of section V.A.) In the paper for the Pontifical Academy of Sciences, I argued that, since all substantial change is occasioned by accidental changes rendering a thing no longer compatible with its original essence, human death must involve *both* the loss of essential human properties *and* the loss of somatic integrative unity. I then considered it axiomatic that these two aspects were inseparable and mutually implicating. But if destruction of the entire brain does not after all constitute death on the basis of loss of integrative unity, we seem cornered into a dilemma of having to assert one of two evidently false propositions: either that the consciousness lost upon brain destruction is not of the human essence or that loss of the human essence does not entail a substantial change.

Actually, in retrospect, this turns out to be merely a pseudo-dilemma resulting from a hidden equivocation between two possible meanings of the phrase "essential human properties." Perhaps we should call the one "properties *constituting* the human essence" and the other "properties *deriving from* the human essence." The first refers to the fact that substantial change in general occurs when something loses its original essence; for a living organism, the loss of "essential properties" in this sense is indeed death. By contrast, the other sense pertains to properties that flow from the nature or essence but the realization of which can be extrinsically impeded. For example, it is "of the essence" of humans to walk upright, to have a prehensile thumb and to see. But one does not cease being human if one is paraplegic, thumbless or blind.

The question of "essential human properties" therefore boils down to the following: Are consciousness, intellection and volition "essential human properties" in the first (substantial) or the second (accidental) sense? Admittedly, consciousness is a much more important and fundamental property than walking, grasping and seeing, but to equate human life and death with the presence or absence of consciousness is to recapitulate the Cartesian error. A human person is not a pure mind either equated with (modern version) or somehow interacting with (Descartes' version) an organic machine called a brain; rather, a human person is a whole human organism, with spiritual and material dimensions marvelously united [Braine 1992]. If a brain lesion were to impede the exercise of mental faculties, even permanently, the person becomes seriously disabled but does not therefore cease to be a living human being or cease to be substantially the same person, any more than a bear ceases to be a bear when it hibernates, even if hypothetically the winter were to last indefinitely.

But – it could be objected – the ursine analogy falls short insofar as the hibernating bear still retains the *potency* to revive and resume bearish activities. The human neurological analog of this example would not be a "brain-dead" body but rather a comatose patient destined to regain consciousness, even if some extrinsic factor were to impede that realization (e.g., a premature death, hypothetically indefinitely maintained general anesthesia, etc.). Even a brainless early human embryo possesses the potency for consciousness and volition in its innate tendency to self-develop anatomical structures ordained to these functions. Whether the potency for specifically human acts is actualizable immediately (as with a sleeping person) or within hours to weeks (as with a

typical comatose person) or after many months (as with an early embryo) – or whether it is perhaps never actualized (as with a sleeping or comatose or embryonic person who dies before becoming conscious) – is all quite irrelevant to the fundamental question whether or not such potency exists in the organism. Clearly, these examples illustrate how it is not the present exercising of specifically human functions, but rather the innate *potency (radical capacity)* for them, that constitutes the truly "essential human property" in the first (substantial) sense.

Thus, at first glance it might seem that for this very reason "brain-dead" (or even "corticothalamically-dead") bodies must differ essentially from sleeping, comatose, and embryonic bodies: insofar as the developed brain cannot regrow once destroyed, total brain infarction would seem to eliminate precisely that potency for specifically human properties that the latter bodies possess. Accordingly, it would seem to follow that, even if the "brain-dead" body possessed integrative unity, it would lack the essence of a human person – i.e., a substantial change would have taken place to a subhuman level. This is same conclusion as that reached in my *Thomist* article, but now through direct metaphysical considerations rather than a hypothetical thought experiment.[o]

But on more careful reflection, is the incapacity to regenerate a new brain truly a loss of the potency for specifically human properties (i.e., a loss of the human essence) or merely an impediment to the actualization of such a potency existing on a deeper level?

Here an example might prove useful. Consider the function of sight. A century ago dense bilateral cataracts would have produced permanent, irreversible blindness. But such irreversibility was not absolute or intrinsic to the blind person; it was extrinsic, conditional upon the state of the art of ophthalmology. From a metaphysical standpoint, the potency to see was not really lost but persisted in the integrity of the retina, optic nerves and brain – and nowadays its re-actualization following cataract surgery is routine. Suppose, however, that both eyes were enucleated: would *that* constitute a loss of potency for sight? Not really. There would be no reason *intrinsic* to the nature of that mutilated body that next-century technology could not devise computer-chip ocular prostheses that would rotate in response to extraocular muscle contractions and stimulate the optic nerve stumps in such a manner as to produce functional vision (even if of lesser quality than natural-eye-mediated vision). To extend the example one step further, neither would the removal or infarction of all visual cortex result in a true loss of the potency to see, rooted in the very being of the living organism. For there would be no reason *intrinsic* to the nature of *that* body that next-millennium technology could not develop specially engineered neuroblasts which, upon implantation in the damaged brain (and perhaps stimulated by appropriate growth factors) would multiply, establish appropriate synaptic connections and reconstitute a functional visual cortex.

The lesson to be learned from this example is that the potency for an organ-mediated biological function ultimately resides not in the organ itself but in the dynamical principle underlying the body's vitality (which scientists might envision as representable in principle by a giant system of differential equations,

and which philosophers call "substantial form" or "soul"). Consequently, destruction of that organ does not eliminate the potency but merely (extrinsically, "accidentally") impedes its actualization. It is important to emphasize that this conclusion does not stand or fall on an imaginary omnipotence of hypothetical future science-fictionesque technology (which perhaps will never come about). The point is rather that, although the actualization of an impeded function might depend on technology circumventing the impediment, the body's *receptivity* to that assistance (i.e., its potency for that function at the ontologically most fundamental level) is inherent in its vitality *per se*. As long as the organism remains in fact a living organism, the potency for functions flowing from its essence remains.

In like manner, the brain is the organ of the internal senses of memory, imagination, etc., as well as of the corresponding motor functions (internal formulation of motor plans, translation of motoric goals into patterned stimulation of muscles, etc.). These functions are part and parcel of specifically human intellection and volition, but, as with potency for sight, the potency for these functions ultimately resides *not in the organ but in the organism.* Theoretically, if brains could be reconstituted (e.g., through implanted futuristically transformed neuroblasts), a "brain-dead" person could be made to regain consciousness and other human functions, although perhaps with a clean mnemonic slate and new personality traits (depending on the details of the new synaptic network). Materialist-reductionists would argue that such a hypothetical scenario, were it to occur, would involve the death of the original person followed by the creation of a new person, rather than the reawakening of the original person; but that viewpoint gratuitously equates "person" with personality traits and memory sets – a question-begging, radical redefinition, rather than a reasoned deduction from the standard definition, of personhood.

If we understand "person" in the traditional, more substantial way (the enduring *substrate* of changeable personality traits, memories, reasoning power, etc.), then it follows from everything above that as long as the human body is alive (from the biological perspective of somatic integrative unity) then the person is alive, even if the person's mental functions be paralyzed by a brain lesion, because the potency for these specifically human functions resides – ultimately – in the organism and not the organ. Nay, more: if we acknowledge an irreducibly immaterial dimension to self-awareness, intellection and volition, then the preservation of potency for these functions despite brain destruction follows even more forcefully than in the visual example, because a physical lesion cannot eliminate essentially spiritual potencies unless it were to occasion a dissociation of the physico-spiritual substantial form from the matter of the body, such that there was no longer even a body to speak of but rather a collection of "dis-integrating" cells and tissues (bringing us back to the criterion of somatic integrative unity).

Thus, if "brain death" does not cause loss of somatic integrative unity (as it now seems not to), then neither does it cause a loss of essential human properties, i.e., a loss of potency for specifically human functions – potency at the most profound ontological level, at which the occurrence or not of substantial change is

determined (this potency not to be confused with shortness of latency or degree of spontaneity in its actualization or with the degree of simplicity of technology necessary to circumvent obstacles to its actualization). Conversely, the basis for maintaining in physical existence a particular instantiation of the human essence is not the integrity of the brain as the organ of consciousness, but the integrative unity of the living human organism, in whose life-principle inheres the innate potency for consciousness and other specifically human properties (and that potency *is* the human essence). And – without diminishing the brain's importance as modulator of bodily functions and its critical role in the (future) survivability of the organism – this (present) integrative unity is not imposed upon the body by the brain (as though *ab extra*) but rather is emergent in the mutual interactions among all parts of the body and is not lost with the destruction of any one part (including the brain).

Thus, the mutual implication of "essential property" and "integrative unity," so strongly insisted upon in my Pontifical Academy paper, was in retrospect nothing more than a tautology (if the equivocal term "essential property" is understood in the substantial sense of "constituting the human essence"), but also an unwitting invitation to either personhood-reductionism or logical paradox (if the term is taken in the accidental sense of merely "flowing from the human essence"). Therefore, in discussions of "brain death" it is better to avoid *both* dichotomizing between "essential property" and "integrative unity" *and* equating consciousness with "essential property" in an unqualified sense.

C. Regrouping

Before a full public emergence from my "brain death" retreat, it was important to understand how the "brain death" concept came about in the first place and became so solidly entrenched in medicine and law, if it was in fact based on false neurophysiologic assumptions. I was also keen to present a positive and reasonable alternative to the diagnosis of death, in a way that would not scandalize or antagonize the transplant community, being, as I was (and am), on the faculty of a major transplant referral center. My new rejection of "brain death" must not be misinterpreted as intrinsically anti-transplantation, and if there were an ethically licit way to harvest unpaired organs without relying on the legal fiction of "brain death," that would be a great step forward indeed.

1. Historical origins of "brain death"

I therefore undertook a thorough review of the history of "brain death," especially focusing on its early phases, to see when and how ideas got off track. Although the neuropathologic entity of total brain infarction was first described in 1902 [Cushing 1902] and the clinical characteristics were first elaborated on in 1959 [Fischgold and Mathis, 1959; Jouvet 1959; Mollaret and Goulon 1959; Wertheimer et al 1959] none of these investigators equated the condition with death itself. The term "brain death" did not enter the scene until the mid-1960s, in response to the rapidly developing field of transplantation medicine [DeVita et al 1993].

A highly informative document from this period is the proceedings of a 1966

international symposium on the ethics of transplantation sponsored by the Ciba Foundation [Wolstenholme and O'Connor, 1966]. A careful reading reveals several striking facts: (1) Proponents of the new brain-based criterion of death viewed it not so much as a refinement in the diagnosis of traditionally-understood death, but rather as a *radically new definition* of death. (2) The rationale implicitly and explicitly offered for such a redefinition was *not* that brain destruction constituted biological death or loss of integrative unity of the human organism, but rather that it entailed permanent unconsciousness and *loss of personhood* (although a philosophy of personhood was not systematically articulated). (3) Many experts were unconvinced by the arguments for equating brain destruction with death. (4) Within a very short time transplant surgeons who initially rejected the "brain death" concept began to remove hearts and livers on the basis of "brain death." For example, Dr. Thomas Starzl stated in 1966:

> I doubt if any of the members of our transplantation team could accept a person as being dead as long as there was a heart beat... [Concerning] renal homografts, a mistake in evaluation of the 'living cadaver' might not necessarily lead to an avoidable death since one kidney could be left. But what if the liver or heart were removed? Would any physician be willing to remove an unpaired vital organ before circulation had stopped? [Wolstenholme and O'Connor 1966 (p. 70)]

Nevertheless, only one year later he skyrocketed to international fame for performing the first liver transplant with long-term success, from a donor meeting criteria for "neurologic death" [Starzl et al 1968]. That same year, 1967, marked the first human heart transplant by Dr. Christiaan Barnard in Cape Town, South Africa, from a young woman pronounced "brain dead" by a neurosurgeon [Barnard 1967, 1987]. Interestingly, in both cases the surgeons waited until asystole, following discontinuation of the ventilator in the operating room, before beginning organ removal, to avoid legal controversy and public misunderstanding [DeVita et al 1993]. This approach eventually proved to be the precursor of the recently developed "Pittsburgh protocol" and other protocols for organ harvesting from so-called "non-heart-beating-cadaver donors" (see below). The next few years could justifiably be described as a period of "wild transplantation," in which major medical centers frantically competed to be the first and do the most, all in a complete philosophical, legal and ethical vacuum regarding the vital status of the donors, and without the scruple of awaiting asystole first [DeVita et al 1993].

During the peak of this phase, in 1968 appeared the famous report of the prestigious Harvard "Ad Hoc Committee to Examine the Definition of Brain Death" [Beecher 1968]. Although nowadays regarded as essentially the first (and therefore excusably overly conservative) set of quasi-official diagnostic criteria for "brain death," the report is more significantly a statement of the reasons perceived at the time for redefining death neurologically. They were basically twofold: (1) to facilitate discontinuation of mechanical ventilation without fear of wrongdoing, and (2) to provide legal justification for unpaired vital organ transplantation. It is noteworthy, in retrospect, that neither of these motivations really required a redefinition of death. It was well recognized even then that

ventilators could ethically be discontinued if they constituted an "extraordinary means;" in fact, the Harvard Committee itself even went so far as to quote (selectively) to that effect Pope Pius XII's 1957 address, "The Prolongation of Life" [Pius XII 1957] (while omitting mention of passages that seem to express at least oblique reservations about the notion of "brain death,"[8] as pointed out by Byrne and colleagues [1979]). Nor was "brain death" truly necessary for the field of transplantation, as non-heart-beating donor protocols would subsequently prove [Arnold et al 1995].[p]

Perhaps the most profound import of the Harvard Committee report was not so much the establishment of the first diagnostic standard for "brain death" as the implicit canonization of a new reductionistic ideology of personhood under the trappings of clinical diagnostic criteria.[q] The title, "A definition of irreversible coma," was no slip of the pen. The word "coma" is not applicable to corpses. It is clear throughout the document that the Committee believed that these patients were biologically alive and deeply comatose, that their hopeless prognoses justified *allowing them to die*, and that their permanent unconsciousness justified *legally defining them as "dead,"* especially for purposes of transplantation. So as to remove any possible doubt about this, the Committee's chairman, Dr. Henry Beecher, explained in subsequent commentaries that: (1) death is a process, not an event; (2) where to draw the line along this process for legal purposes is arbitrary and culturally relative; and (3) the utilitarian motivation of saving lives through organ transplantation is a good (and sufficient) reason for drawing the line at "brain death" [Beecher 1968; Beecher and Dorr 1971].

Perhaps more disturbing was the fact that some of the early cardiac transplant surgeons had at best ambivalent feelings about the vitality of the patients whose beating hearts they were cutting out, and at worst a belief that they were actually killing the donors, but that this was justified by the saving of other lives [Castelnuovo-Tedesco 1971].

I was astonished to discover that the now "official" rationale of "brain death" (i.e., loss of somatic unity), was actually a *post facto* rationalization for what had already been codified into law and implemented in practice, based on utilitarianism and a reductionistic theory of personhood [cf. Singer 1994]. The "integrative unity" theory did not enter mainstream thinking until a series of influential papers by Bernat and colleagues beginning in 1981 [Bernat et al 1981, 1982; Bernat 1984; Culver and Gert 1982] and the landmark report of the President's Commission in 1981 [President's Commission 1981], over a decade into society's developing inextricable dependence on "brain death" being death.

2. Pseudo-consensus

Moreover, as I had already pointed out in my paper for the Pontifical Academy of Sciences [Shewmon 1992], despite over two decades of educational effort by the medical establishment, very few people seemed *really* to believe that "brain death" is death. Although failure to grasp the complexities and subtleties is perhaps understandable on the part of journalists and other non-medical people, it is of concern that the majority of health-care professionals, including even those directly involved in organ procurement, have confused notions about "brain

death" or frankly believe that it is merely a legal fiction [Shewmon 1992; Youngner 1992; Youngner et al 1989]. I was discovering through informal "Socratic" conversations with colleagues that even most neurologists are unable to render a coherent explanation of why total brain infarction should be equated with death. For most, "brain death" is simply an equivocal formula that they learned to accept during training, for no more profound a reason than that everyone else accepted it.

An opportunity to verify these sociological impressions came with an invitation in 1993 to give Pediatric Grand Rounds at UCLA on the pathophysiology of, and diagnostic criteria for, "brain death" in children. For motives unsuspected by the listeners (and also to enliven the talk), I began with an informal audience poll: How many thought that "brain death" represented true death of the patient, and how many thought it was ultimately a legal fiction applied to deeply comatose and fatally injured but live patients? About a third raised their hands endorsing the latter interpretation. These were not medical students whose naïveté on the subject could be excused; the majority were pediatric residents, fellows and attendings, many directly involved in organ transplantation in one of the country's major transplant centers.

I also came to realize that not even the gurus of "brain death" necessarily equated it with biological death. For example, as recently as 1993 a chapter on "brain death" by Harvard neurosurgery professor Dr. Peter Black contains a section entitled "Philosophic Issues in Brain Death Declaration" [Black 1993]. In it he recounts and summarily excludes each of a series of possible rationales for equating "brain death" with death, among which somatic integrative unity is not even mentioned. Although Black does not identify a single rationale that he himself finds convincing, he continues with characteristic surgical pragmatism: "Brain death should be a diagnosis made without hesitation in the intensive care unit." (p.464) One of the most explicit disavowals of "brain death" as death is from Dr. Ronald Cranford himself, one of the best known experts on "brain death" and related conditions and long-time chairman of the Ethics Subcommittee of the American Academy of Neurology. In an article advocating consciousness as the basis of personhood, he summarized his view on the nature of persistent vegetative state in the following way:

> It seems then that permanently unconscious patients have characteristics of both the living and the dead. It would be tempting to *call them dead and then retrospectively apply the principles of death, as society has done with brain death*. (emphasis added) [Cranford and Smith 1987 (p.243)]

Another telltale indicator that physicians in general are inwardly at least ambivalent, if not frankly doubtful, about equating "brain death" with death – despite possible verbal protestations to the contrary – is their reluctance to treat these bodies as dead, *apart from the context of organ transplantation*. If they are really dead, there should be nothing wrong with using them for medical experimentation that could benefit many people but would be harmful and unethical to carry out on live subjects: for example, assessing the potential toxicity and lethal doses of new drugs, comparing treatment efficacy for induced

infections, obtaining multiple serial liver, kidney or other organ biopsies to study the pathophysiology of certain experimentally induced diseases, etc. Although there have been rare isolated reports of "brain-dead" patients as research subjects [Casado de Frias et al 1980; Coller et al 1988; Kolff et al 1984], the fact that this practice has never caught on, despite the increasing political obstacles to animal research and the great methodologic preferability of human over animal bodies anyway, suggests a widespread intuition that these patients may be capable of being harmed in ways that standard cadavers are not [Fost 1980; La Puma 1988]. Similarly, "brain-dead" patients would be far more ideal for anatomic study and surgical practice of medical students and residents than cadavers in a morgue [cf. Gaylin 1974], yet no one seriously advocates this. Why not?

Finally, in late 1995 I experienced the *coup de grace* that convinced me that the medical community might be ready to hear that perhaps "brain death" was not death after all. One day while on ward duty, I was consulted to confirm a "brain death" diagnosis in the sad case of a ten-year-old victim of a drunk driver. There was unequivocal neuroimaging evidence for massive brain edema and herniation, and she fulfilled all the standard clinical and EEG criteria for "brain death." Her other organ systems were functioning quite well, and she required relatively little by way of intensive care. None of my colleagues had as yet any hint about my change of opinion on the nature of "brain death," although I had recently begun to prepare the ground by preferring to speak of "total brain infarction" rather than "brain death." While the physician in charge of the intensive care unit and I were performing the required apnea test together, we contemplated the tragedy of such a beautiful young life snuffed out so needlessly. All of a sudden the intensivist, with no prompting whatsoever and with no idea of the personal significance to me of his comment, exclaimed: "Isn't it amazing how well the body can function without a brain!"

3. Clinical criteria for death, revisited

If "brain death" is *not* death, then what *is*, and how should death be diagnosed in contemporary practice? The definition of death as the loss of integrative unity and immanent dynamism of a living body still remains valid. If such loss does not occur with destruction of the brain, it surely occurs when all major organ systems, or a critical number of them, are irreversibly damaged beyond a critical degree. The almost universal context is a terminal cardiac arrest, after which all major organs rapidly become increasingly damaged by anoxia and ischemia. A thermodynamic "point of no return" is soon passed, beyond which the body's entropy-resisting dynamic unity is irretrievably lost and decomposition (unopposed progression to entropy) will inexorably proceed (even despite all theoretically possible therapeutic maneuvers, such as mechanically perfusing the body with oxygenated blood, and even if some individual organs or tissues such as skin, bones, or corneas might remain viable for a while).

The exact timing of this thermodynamical turning point cannot be empirically determined with unlimited precision. It surely depends on many uncontrollable and/or unknowable factors, including body temperature, pretreatment with potentially protective drugs, the robustness of pre-arrest health, the functional

reserve of various organs, etc. Under usual circumstances, perhaps 20 to 30 minutes following circulatory arrest would be a reasonable guess. The mere fact that one cannot pinpoint the exact moment of death hardly implies that it does not occur at a definite moment.[r] Through various clinical signs one can usually determine that death *has* occurred sometime in the past, or that it has not occurred *yet*, but there is no logical requirement that we possess the means to determine for every individual case that it occurs... right now!

The traditional clinical criterion for declaring death – that is, the moment of final cessation of heartbeat – is clearly a legal fiction. It is a useful fiction, and perhaps even a socially necessary one, but a fiction nonetheless. The real moment of death, in the strict philosophical sense, occurs sometime later. This is why it is proper for priests to give conditional anointing and absolution to bodies well after death has been medically declared, though prior to unequivocal signs of early decomposition such as rigor mortis.[s]

It is important to recognize that some "brain-dead" patients may indeed be dead, but not *because* they are "brain dead." These are the ones who, despite aggressive intensive care, progress relentlessly to cardiovascular collapse, often with signs of dysfunction of other organ systems as well. That irreversible downward spiral could well reflect a loss of integrative unity due to supracritical dysfunction of *multiple* organs, the brain being but one of them. This is most likely to occur with diffuse etiologies, such as cardiac arrest, massive trauma with shock, etc. When the cause of the brain destruction is primarily intracranial, however, the other organ systems are intact and integrative unity is not necessarily lost.[t] At present, there is no reliable clinical criterion to distinguish early in the course between a dead "brain-dead" and a live "brain-dead" patient – only in retrospect: some that rapidly and inexorably deteriorate despite intensive care may have been dead all along, and those that stabilize, at least for some days, should be presumed alive.

4. Organ transplantation

This revised view of "brain death" carries immediate and profound implications for the field of transplantation. Life-saving organ transplantation is certainly a praiseworthy undertaking which ought to be promoted by every legitimate means. If there be any doubt, however, whether the potential donor might still be alive, (in the words addressed by Pope John Paul II to our 1989 Working Group:) "the respect due to human life absolutely prohibits the direct and positive sacrifice of that life, even though it may be for the benefit of another human being who might be felt to be entitled to preference." [John Paul II 1989] This injunction was reinforced in the Pope's recent encyclical, *Evangelium Vitae*: "Nor can we remain silent in the face of other more furtive, but no less serious and real, forms of euthanasia. These could occur for example when, in order to increase the availability of organs for transplants, organs are removed without respecting objective and adequate criteria which verify the death of the donor." [John Paul II 1995 (section 15)]

Surely the great majority of transplant specialists have been acting in perfectly good conscience, just as I, as a neurologist, in good conscience diagnosed "brain

death" in potential donors and wrote articles supporting its equivalence with death. On the other hand, many seem to have at least a confused conscience, insofar as they hold incoherent and contradictory ideas about the nature of "brain death." Operating room nurses involved in transplantation often experience psychological problems stemming from latent moral doubts over the vital status of the donors [Youngner et al 1985]. More disturbing still is that some cardiac transplant surgeons have acknowledged feeling that they actually kill the donors but that this is justified by the importance of the end [Castelnuovo-Tedesco 1971].

If brain death is in fact *not* death, it follows that such sentiments correspond to an objective reality, i.e., that many transplant operations do involve the direct killing of the donor, especially when the beating heart is excised. This would be an objective evil, regardless of any possible subjective uprightness of conscience and lack of moral culpability, and as such it carries adverse consequences for society by contributing to the general erosion of the respect for human life. We all have an obligation to form our consciences in conformity with the truth [John Paul II 1993]. If, therefore, someone involved in transplantation were to study the matter more deeply and arrive at the conclusion herein proposed, that person would be morally obliged to cease participating in those procedures that carry even a small risk of directly killing or harming the donor.[u] Moreover, it would seem that anyone exposed to the arguments presented here, even if not entirely convinced, would have to admit that there is at least a morally significant *possibility* that "brain death" *might not* be death – especially given that the introducers of the concept intended to *redefine* death in terms of unconsciousness rather than *diagnose* it as the cessation of biological life of the human organism.[v] It would seem, therefore, that the probability of false-positive conceptual error in the neurological diagnosis of death of organ donors is by no means non-negligible (contrary to my assessment in 1992 [Shewmon 1994]).

But it would be a mistake to assume that the demise of "brain death" automatically implies the demise of vital organ transplantation – only of vital organ transplantation *as traditionally practiced*. The Fifth Commandment says "Thou shalt not kill," and the "dead donor rule" of the Uniform Anatomical Gift Act says that donors of unpaired vital organs must be dead before the organs are removed. In the context of transplantation most people instinctively equate the Fifth Commandment with the "dead donor rule," but the two are not logically equivalent and only the former is a divine mandate. What if, for example, in a very particular circumstance it were possible to remove unpaired organs, including even the heart, from a live donor without causing or even hastening death? Such a paradigm would, in fact, be a variation on the theme of what has recently come to be known as "non-heart-beating-cadaver donors" [Arnold et al 1995], but eliminating the fiction that they are "cadavers."[w]

In the several paragraphs that follow, this approach is tentatively outlined, with the *caveat* that it requires study and approbation by expert orthodox moralists, to whose opinion I respectfully defer. Although perhaps tangential, strictly speaking, to the central topic of the nature of "brain death," I feel compelled to mention it here both to stimulate said study and to emphasize that

historically the ethical presumption that all vital organ transplantation requires dead donors has never really been thoroughly reasoned through. A critical analysis is important, because *if* at least some form of non-heart-beating donation *could* be morally licit, then the utilitarian motivation for the charade of "brain death" vanishes and organ transplantation could continue (and even flourish better) without all the adverse moral, psychological, and social consequences incurred by radically redefining death for that purpose.

This ethical disclaimer having been made, consider a patient on clearly *morally extraordinary (disproportionate)* life support (typically a ventilator), who is about to have that support licitly withdrawn and who, independent of that decision, also wants to donate organs.[9] Suppose also a high probability that the patient will die very quickly upon termination of that support. Instead of the withdrawal taking place in the intensive care unit, however, it is done in the operating room with surgical teams poised. Perhaps, with the patient's consent, arterial catheters have been placed in readiness to perfuse at an appropriate time the organs of interest with a cold ischemia-protective solution. The life support is then discontinued and asystole awaited. After a brief interval (short enough not to damage the transplantable organs but long enough for moral certainty that spontaneous recovery will not occur[x]) the organs of interest are perfused and the surgical teams begin their work.

In such a scenario, the patient would probably not yet be dead at the moment of organ removal. Cardiopulmonary resuscitation *could* be successful; but it would constitute an extraordinary means that has been decided ahead of time to be legitimately foregone. In the absence of circulating blood, however, "vital" organs are no longer vital, including even the nonbeating heart; their mere presence in the body contributes nothing to the body's physiological integrity or remaining brief span of life (perhaps on the order of tens of minutes); therefore, their removal would neither cause nor even accelerate death. It is generally accepted that healthy individuals may licitly donate a single kidney or a piece of liver on the dual basis that (1) the functional integrity of their body is not compromised and (2) the gift of life for the recipient sufficiently justifies the risks of surgery and the structural mutilation. The retrieval of unpaired vital organs in the manner described would seem to be morally equivalent, at least in principle, to these classic examples of licit live donation.

Recently something similar was pioneered in Pittsburgh, and now over 30 medical centers have been experimenting with protocols for "non-heart-beating-cadaver donors" similar to that "Pittsburgh protocol" [Arnold et al 1995; Fox and Christakis 1995; Spielman and McCarthy 1995; Youngner and Arnold 1993; (see also the whole issue of Kennedy Inst J 1993, vol. 3)]. The main difference from the approach outlined above is that, instead of straightforwardly laying aside the "dead donor rule" in this unique circumstance, the Pittsburgh protocol insists on the ruse of declaring death after only two minutes of asystole.[y]

"Non-heart-beating donor" protocols have proved technically successful in terms of graft viability, but the practical experience so far has highlighted various logistical, safety, public policy, and aesthetic concerns which still need to be worked out and publicly debated before widespread implementation (e.g.,

informed consent without psychological coercion, conflict of interest on the part of the health-care team, moral certainty of the lack of potential for spontaneous recovery at the moment of initiation of organ retrieval, the practicality of effectively regulating the practice to stay within strict ethical guidelines, etc.) [Arnold et al 1995; Fox and Christakis 1995; Spielman and McCarthy 1995; Youngner and Arnold, 1993].[z]

I emphasize that I am not here advocating that everyone immediately jump on the non-heart-beating-donor-protocol bandwagon at this point; I am merely suggesting that such an approach seems to merit serious consideration as a possibly licit way to obtain transplantable organs even if "brain death" is not death. Moreover, the pool of potential donors would be even larger than under the present regime, because not only would all "brain dead" donors be automatic candidates, but so would many "non-brain-dead" patients on ethically extraordinary life support who are presently excluded by the "dead donor rule."

It is of course conceivable that some of the secondary ethical and policy problems could turn out to be so intractable in practice that there might be no safe and prudent way to implement non-heart-beating-donor protocols. It is also conceivable that an in-depth study by expert moralists will uncover some more fundamental ethical obstacle that I have not considered here. Time will tell. The main point is simply that, contrary to popular belief, the conceptual downfall of "brain death" and a reversion of legal definitions of death to the perennially valid cardio-respiratory (really circulatory-respiratory) standard would *not necessarily* have to bring organ transplantation to a screeching halt. On the contrary, it could conceivably enhance transplantation while at the same time enhancing the integrity of conscience of those involved in it and fostering general respect for the inviolability and dignity of human life.[aa]

D. Re-emergence – Cuba, 1996

My decision finally to "go public" with these ideas among professional colleagues happened to coincide with an invitation to give one of the keynote addresses at the Second International Symposium on Brain Death, held in Havana, Cuba, February 27 to March 1, 1996. The organizer, Dr. Calixto Machado, had liked my paper for the Pontifical Academy of Sciences and assumed that I would develop the theme further along the same lines. Needless to say, no one was quite expecting the discourse they received on "Somatic integrative unity: a nonviable rationale for 'brain death.'" To my great satisfaction, high-level discussions were catalyzed, and the invisible shield I had brought for protection against flying tomatoes was never needed.

The conference was fascinating in a number of ways. In a sense it was as though two parallel conferences. Many Latin American countries are only recently introducing "brain-death" legislation, and their physicians are just beginning to grapple with the issue of diagnostic accuracy. Listening to many of those talks was like passing through a time warp of a quarter-century (with certain notable exceptions [Garcia 1995a&b; Machado 1995]).

Among the North American contingent, by contrast, there seemed to emerge, to my surprise, a general agreement with my thesis that "somatic integrative

unity" was indeed "a nonviable rationale for 'brain death.'" For long-time advocates of higher-brain formulations, this was nothing new, but even former proponents of "whole-brain death" manifested a notable refocusing of explanatory emphasis. For example, neurologist Julius Korein, who in 1978 characterized the brain as the "critical organ" for the *thermodynamic integrity of the body* (as well as for the mind) [Korein 1978], was now describing the brain's criticality almost exclusively in relation to *consciousness and personhood*, dismissing the aspect of somatic integrative unity as "unimportant." Such a paradigm-shift implicitly acknowledged the validity of my clinical and neurophysiological arguments against the brain as central integrating organ of the body.

The Second International Symposium on Brain Death thus proved to be both gratifying and disturbing: gratifying in that many of the North American delegates seemed to accept my arguments that "brain death" is *not*, after all, death of the biological human organism; disturbing in that many also seemed to regard that as irrelevant to the problem of human death. They equated "brain death" with death of the *person*, viewed from a materialistic-reductionistic and culturally relativistic perspective as an abstraction dissociable from biological human life.

In one of the papers presented, Karen Gervais, an advocate of "higher-brain death," independently seconded one of my historical points, observing that "in adopting a brain death criterion for declaring death, we [society] tacitly adopted a new concept of human death, namely, that human death is the permanent absence of consciousness." Among the North Americans, at least, there appeared to be widespread agreement with her conclusion that "*if* the brain dead patient is dead, then so is the PVS patient" (emphasis added), because the only *coherent* argument that "brain death" is death logically applies to PVS as well (i.e., permanent unconsciousness plus a reconceptualization of both death and personhood) [Gervais 1996]. I also agree with that statement in its conditional form, and would point out that the contrapositive also logically follows: "and if the PVS patient is *not* dead, neither is the brain-dead patient."

Nor is this equation of "higher-brain death" with nonpersonhood merely inconsequential theorizing on the part of certain academic philosophers. Another presenter cited the astonishing results of a 1993 attitude-survey of 500 neurologists and medical directors of nursing homes, in press at the time and subsequently published [Payne et al 1996]. Incredibly, half of the respondents believed that PVS patients should be considered dead and almost two-thirds believed it would be ethical to remove their vital organs for transplantation.

VII. Epilogue

As the Cuba conference progressed, it became increasingly clear that the scope of *physiologically cogent* debate surrounding "brain death" has narrowed to a single *nonphysiological* issue: the concept of "personhood." Unfortunately, this controversy is a purely metaphysical and definitional one which cannot be resolved with further empirical data. Western society seems to be rapidly

approaching a stage where the moment of death will be determined not so much by objective bodily changes as by the philosophy of personhood of those in charge. If this trend continues, philosophers, not doctors, will ultimately (though indirectly) be the ones determining the timing of death for purposes of death certificates. And which philosophers they are will depend on the outcome of the on-going *coup d'état* against the traditional Judaeo-Christian ethic [cf. ___ 1970].

The choice of definition of "personhood" carries profound implications not only for "brain death," but also for other timely issues such as vegetative state, dementia, mental retardation, abortion, and infanticide. Ultimately at stake is the security or peril of every socially disvalued category of human being. "Personhood" is now one of the most critical fronts in the perennial war between the "culture of death" and the "culture of life" [John Paul II 1995]. Whether society comes to "officially" regard personhood as a property of consciousness (understood in turn as a purely physical epiphenomenon of the brain), or consciousness as a property of persons (understood as substantial and inherently spiritual in nature), carries consequences of unfathomable magnitude for the future.

Whether orthodox proponents of "brain death" like it or not, this is what the "brain death" debate is presently all about among the pace setters of bioethics. There is no question that truth will eventually prevail. The only questions are: after how long a time and at what human cost? May this account of my recovery from "brain death" serve in some way to reduce both.

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FOOTNOTES

1. This article is derived from a lecture given by the author at the Internationale Akademie für Philosophie im Fürstentum Liechtenstein, March 28, 1995, an edited transcript of which is in press [Shewmon 1997].

2. Because of its equivocal meanings and the arguability of its equivalence with death, the term "brain death" will always be placed in quotation marks, deflating its terminologic status and connoting "what people commonly understand as 'brain death.'" The term has caused so much confusion that many (including myself) favor abandoning it altogether [Shewmon 1992, 1994].

3. This diminutive enumeration excludes sporadic editorials and letters to the editor [e.g., Evans and Lum 1980, 1986; Siegler and Wikler 1982; Soloveichik 1978; Wikler and Weisbard 1989], and brief nonsystematic musings [e.g., Harrison 1982; Nilges 1990]. In the Spanish language a reasoned though brief critique of "brain death" has been published by Rodríguez del Pozo [1993a&b].

4. The factors that led me from theism in general to Catholicism in particular are not germane to the present topic. Suffice it for the reader to know that I did become a Catholic as a background datum relevant to certain aspects of the narrative to follow.

5. Here and a few other places I cite references that postdate the story line; although they played no role in my thinking at the time, they are included as supplementary material for a fuller explanation of the concepts at issue.

6. The word "brain" is here placed in quotes, because, although the functions at issue are normally mediated by the brain, in the situation under consideration the brain *as an organ* has been destroyed and the function-mediating residual islands of neural tissue in a sea of necrosis hardly constitute a true brain.

7. This general acceptance of "brain death" by orthodox Catholic theologians and thinkers continues [Chagas 1986 (pp. 113-114); Diamond 1990; Moraczewski 1993; Pontifical Council for Pastoral Assistance 1994 (#129, p.114); Tonti-Filippini 1991; White et al 1992].

8. "In case of insoluble doubt, one can resort to presumptions of law and of fact. *In general, it will be necessary to presume that life remains,* because there is involved here a fundamental right received from the Creator, and *it is necessary to prove with certainty that it has been lost*.... considerations of a general nature allow us to believe that human life continues for as long as its vital functions – distinguished from the simple life of organs – manifest themselves spontaneously *or even with the help of artificial processes*." (emphasis added) [Pius XII 1957 (pp. 396-397, 398)]

The latter passage has been interpreted both against and in favor of "brain death," depending on whether the remaining "vital functions" are attributed to the body as a whole or merely to "the simple life of organs" – an empirical question about which the pope expressed no explicit opinion

and left to the proper domain of medical science.

9. Explicit patient consent is specified here merely for the sake of focusing on the question of fundamental licitude of this approach to organ harvesting. Analytical complications from tangential issues, such as proxy consent, determination of competency, conflicts of interest, possibility of psychological coercion, etc., are intentionally set aside here.

ENDNOTES
Retrospective comments from 27 years later

References for Endnotes (Endnotes themselves to follow)

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[a] That is a very strong proviso. Although I still believe that in principle such ethical analysis is valid, I am doubtful whether in practice moral certainty of no potential for autoresuscitation can be achieved within the time frame of viability of donor organs. See [Eble 2024] regarding moral certainty and endnote x concerning potential for autoresuscitation.

[b] That paper was partially prepared but not completed. Instead, my continually evolving ideas were expressed in multiple articles and chapters published since the *Apologia*.

[c] It is now recognized that the process of self-destruction remains incomplete in a much higher proportion of cases than previously thought, and it is often inhomogeneous. Neuropathology on many patients diagnosed "brain dead" has revealed patchy areas of relatively preserved tissue interspersed among patches of necrotic tissue [Walker et al 1975; Wijdicks and Pfeifer 2008; Folkerth et al 2022]. Hypothalamic control of posterior pituitary function is preserved in half of cases diagnosed "brain dead," and hypothalamic control of anterior pituitary function is preserved in around four-fifths [Nair-Collins et al 2016; Nair-Collins and Joffe 2021].

The American Academy of Neurology's original "practice parameters for determining brain death in adults," [American Academy of Neurology 1995] and the guideline updates for the United States [Greer et al 2023] and Canada [Shemie et al 2023] explicitly exclude hypothalamic function as irrelevant to the diagnosis. In reaction to the U.S. update, 151 influential Catholics from a variety of disciplines, including both those who defend and those who reject "brain death" in principle, endorsed a statement that diagnoses of death according to the new guideline lack moral certainty, along with concrete action steps in consequence [Eble et al 2024a; an abbreviated version was published as Eble et al 2024b].

Two years after my *Apologia*, the Brazilian neurologist Cicero Coimbra published a seminal paper proposing global ischemic penumbra as an important yet unrecognized mimic of brain death, due to blood flow to the brain being low enough to prevent neuronal function but not low enough to cause necrosis [Coimbra 1999]. Probably this phenomenon was behind the rare, spectacular, and very disturbing cases of patients clinically diagnosed "brain dead" who recovered various degrees of brain function, including complete recovery [Coimbra 2009; Shewmon and Salamon 2021; Shewmon 2021 (pp. 11-16); https://www.respectforhumanlife.com/survivors].

[d] An influential additional reference that could have been included in the original *Apologia* was [Grigg et al 1987].

[e] Although *in principle* demonstration of absent blood flow to the entire brain would provide certainty of total brain infarction, *in practice* no test of brain blood flow in clinical use has been validated to possess zero risk of a false positive result (declaring no flow when some flow is present). In particular, none has been validated to be able to distinguish between no flow and penumbra level flow in all parts of the brain (especially the brainstem and hypothalamus). Moreover, there is abundant evidence that the tests are in fact incapable of that distinction: their specificity for "brain death" has not been validated, and there are case reports of preserved brain functions (particularly hypothalamic) despite lack of visualizable flow [Arita et al 1993; Coimbra 2009; Joffe et al 2010; Latorre et al 2020; McCormick and Halmi 1970; Shewmon 2017; Shewmon and Salamon 2021; Shewmon and Salamon 2022; Sugimoto et al 1992; Wijdicks 2011; Zuckier 2022].

[f] But even herniation of the brainstem through the foramen magnum is not necessarily irreversible [Elwatidy 2009; Hamed et al 2016; Motah et al 2014; Pérez-Bovet et al 2012; Stiver et al 2009; Wang et al 2018].

[g] A peer-reviewed article was subsequently published about these two cases plus two others. [Shewmon et al 1999] Citing our article, Bjorn Merker published a more extensive paper supporting the possibility of consciousness without a cerebral cortex [Merker 2007].

[h] This suspicion proved prescient. Functional MRI and electrophysiological studies would later demonstrate that some 15-20% of patients clinically in a PVS are in fact inwardly conscious: what I called a "super-locked-in state" and what would later come to be called "cognitive-motor dissociation" [Edlow et al 2021; Edlow and Naccache 2021].

Although cognitive-motor dissociation has been discussed almost exclusively in the context of clinical PVS, it also occurs in the context of "brain death": rare cases of misdiagnosis, where apparently "brain-dead" patients heard doctors tell their families that they were dead; but they were both alive and inwardly aware of the conversation, yet completely unable to move or indicate that awareness in any way. One, Zack Dunlap, had been a registered organ donor and was about to be taken to the operating room for organ harvesting when his cousin, a nurse, elicited a withdrawal response. The operation was called off, and Zack made an essentially complete recovery [Celizic 2008; Morales 2008]. He described his ordeal on NBC's "Dateline" program (March 23, 2008) and in an interview available on the internet [https://www.youtube.com/watch?v=ZXFM9INV-bQ, especially 6:10-7:02]. Another person with a similar story is Jennifer Hamann, who decided to become a nurse after the harrowing experience [https://www.respectforhumanlife.com/survivors; https://facinglife.tv/fln-episode/jennys-story-i-need-my-organs/]. It is disturbing to consider that there have likely been similar patients, whose misdiagnosis was not discovered at the last minute, who were inwardly aware as they were taken to the operating room for their organs to be removed (perhaps without anesthesia).

[i] See the excellent article on moral certainty by Eble [Eble 2024].

[j] I developed the comparison between "brain death" and high cervical cord transection in great detail in a subsequent paper [Shewmon 1999].

[k] Later I would elaborate on this point in the lead article of an issue of *Journal of Medicine and Philosophy* [Shewmon 2001] and in even greater detail in an article in *Communio*, in which I made a tentative foray into a philosophy of integration [Shewmon 2012].

[l] I did not perform an apnea test on that occasion, as it was logistically unfeasible. The apnea test documented in his medical records was considered to have demonstrated a lack of respiratory drive, fulfilling the diagnostic criteria for "brain death" in effect at the time. Subsequently, the procedure for apnea testing became more stringently codified. In retrospect, it is possible that the administered apnea test might not have met today's standards.

[m] This literature search became the seed of a formal research project culminating in the publication of around 170 cases of "brain death" with survival longer than 1 week, 56 of which had sufficient medical information for a meta-analysis. This work became the lead article in the December 1998 issue of *Neurology*, the official journal of the American Academy of Neurology [Shewmon 1998]. My thesis that these patients were not biologically dead was seconded by Dr. Ronald Cranford in a humorously titled editorial [Cranford 1998].

[n] Later I presented an extensive critique of decapitation and brain-in-a-vat thought experiments at the 2006 Working Group of the Pontifical Academy of Sciences [Shewmon 2007]. A slightly modified version became a chapter in a book critiquing "brain death" published soon after [Shewmon 2006].

[o] This argument was put forward by Germaine Grisez and Fr. Peter F. Ryan, S.J., at a conference on "brain death" sponsored by the Westchester Institute, Washington, DC, April 10-11, 2008. There Grisez told me that I had been on the right track with the *Thomist* article and that it was unfortunate that I had subsequently renounced it. That analytic approach was further developed by Grisez and later published, coauthored with Patrick Lee [Lee and Grisez 2012]. Lee has continued to promote this position [Lee 2016]. My response to their critique, laid out in a recent book chapter, is that the physical substrate for the "radical capacity" for higher mental functions is not the brain but the DNA and epigenetic factors that are part and parcel of the life process throughout the human organism [Shewmon 2022]. To quote the salient two paragraphs from that chapter (pp. 33-34):

> "Rational nature" is not synonymous with capacity to exercise rationality. An impediment to actuating our most noble and species-specific functions (i.e., mental functions) does not eradicate our nature as rational animals any more than bilateral ocular enucleation eradicates our nature as seeing animals. Human nature is expressed through the human DNA present in every cell throughout the body. That DNA underlies the capacity for endogenous generation (autopoiesis) of every body part, including the brain.

That capacity is obviously active in the embryonic stage and is gradually inactivated through epigenetic modifications as development proceeds. In principle, the autopoietic potential inherent in DNA could be reactivated to repair a damaged brain or regrow destroyed parts of a brain or even an entire brain.

That sounds easy to dismiss as mere science fiction, but only a few decades ago genetic engineering was unimaginable. Epigenetic engineering, capable of reactivating selective autopoietic potential latent in DNA is already on the horizon: the potential to regrow amputated limbs is starting to be unlocked in experimental animals [Muneoka et al 2008; Murugan et al 2022]. However, the point is not whether epigenetic engineering is easy, or practical, or possible today; it is that our rational nature is diffuse throughout our bodies, not localized in our brains. Although the brain may ground the *capacity* for rationality, it does not ground the *radical capacity*, i.e., the capacity to develop the capacity for rationality inherent in human DNA in the context of a living organism.

[p] See the caveat in endnote x.

[q] That reductionistic ideology of "personhood" is more prevalent today than at the time of the Harvard Committee report; it underlies the new diagnostic guideline and its rationale [Shewmon 2022; Shewmon 2024].

[r] My strongest argument that death is not a process was expressed in a chapter coauthored with my wife, Dr. Elisabeth Seitz Shewmon, who is a Slavic linguist. We presented both semantic and systems-dynamical reasons that death occurs at a moment during the continuous process from dying to decomposition, and that for nonlinear systems in general (of which living organisms are an example *par excellence*), unobservable discontinuities of state often take place beneath continuous changes in observable parameters [Shewmon and Shewmon 2004].

[s] Thirteen years later I proposed a "semantic bifurcation" into civil/legal/relational death (called "passing away"), which occurs at the moment of *permanent* (not necessarily irreversible) cessation of circulation, and ontological death (called "deanimation"), which occurs at the moment of *irreversible* loss of endogenous anti-entropy [Shewmon 2010]. At the time of the *Apologia*, I regarded death univocally as the latter; therefore, I considered declarations of death at the moment of permanent circulatory arrest to be "legal fictions."

Recently the American Academy of Neurology with other professional societies published an update of the diagnostic guideline for "brain death," in which the qualifier "irreversible" was changed to "permanent" [Greer et al 2023], following the lead of the Canadian clinical practice guideline [Shemie et al 2023]. As explained in an opinion piece in *Neurology*, although I still favor "permanent" in principle, I oppose the wording change in practice unless it be accompanied by a parallel change in homicide laws, to close a loophole by which physicians could intentionally or negligently not treat reversible arrest of circulation or brain function when they had an ethical obligation to do so, claiming that the patient was already dead on the basis of "permanent" cessation of circulation or brain function [Shewmon 2024].

[t] See [Shewmon 1998] for statistical support for this assertion.

[u] See once again the Statement on moral certainty [Eble et al 2024a; Eble et al 2024b].

[v] See again [Eble 2024].

[w] Over time, the acronym "NHBD" ("non-heart-beating donor") would be replaced by "DCD" ("donation after circulatory death").

[x] Therein lies the rub. Given the data on autoresuscitation published since the *Apologia*, I feel bound to assume – until proven otherwise – that moral certainty of no potential for autoresuscitation cannot be achieved by any "no-touch" period that favors viability of transplanted organs. Here are the reasons for that conclusion.

First, it is important to distinguish between "controlled" (withdrawal of life support) and "uncontrolled" (cessation of unsuccessful efforts at cardiopulmonary resuscitation (CPR)) conditions. Most protocols concern *controlled* donation after circulatory death (DCD, formerly called non-heart-beating donation (NHBD)), which is the scenario envisioned in the *Apologia* except

for the charade of declaring the patient "dead." (The *Apologia* regarded DCD as a form of donation *inter vivos.* According to my later semantic bifurcation proposal [Shewmon 2010], DCD would be understood as donation from a "deceased" person who has not yet "deanimated.") Key to the ethical legitimacy of DCD, regardless how the donor's ontological status is conceived, is moral certainty that the heart will not spontaneously begin beating again after it had stopped – so-called "autoresuscitation;" when this occurs following an unsuccessful CPR attempt, it has also been called the "Lazarus phenomenon."

Various "no touch" times were proposed following the introduction of DCD in Pittsburgh in 1993, none of them based on any empirical data. The 75 seconds employed in the infamous infant heart transplants was scandalously short [Boucek et al 2008]. The original Pittsburgh protocol [DeVita and Snyder 1993] had a 2-minute "no touch" period, which is now generally acknowledged to have been insufficient. In 1997 the Institute of Medicine recommended "at least 5 minutes of absent heart function" [Institute of Medicine 1997 (p. 61)], while some programs required at least 10 minutes, "particularly in Europe and particularly for uncontrolled NHBDs" [Institute of Medicine 1997 (p. 58)]. All these numbers were pulled out of the air, initially on the grounds that there had allegedly been "no case of autoresuscitation occurring more than 65 seconds after loss of circulation" [Joffe et al 2011 (p. 4)] so that 2, and especially 5, minutes were considered to be sufficiently conservative to confer moral certainty of no potential for autoresuscitation.

An extensive literature review published in 2010 by Hornby and colleagues concluded the following [Hornby et al 2010 (abstract)]:

> *Data Synthesis:* A total of 1265 citations were identified and, of these, 27 articles describing 32 cases of autoresuscitation were included (n 32; age, 27–94 yrs). The studies came from 16 different countries and were considered of very-low quality (case reports or letters to the editor). All 32 cases reported autoresuscitation after failed cardiopulmonary resuscitation, with times ranging from a few seconds to 33 mins; however, continuity of observation and methods of monitoring were highly inconsistent. For the eight studies reporting continuous electrocardiogram monitoring and exact times, autoresuscitation did not occur beyond 7 mins after failed cardiopulmonary resuscitation. No cases of autoresuscitation in the absence of cardiopulmonary resuscitation were reported.
>
> *Conclusions:* These findings suggest that the provision of cardiopulmonary resuscitation may influence autoresuscitation. **In the absence of cardiopulmonary resuscitation, as may apply to controlled organ donation after cardiac death after withdrawal of life-sustaining therapies, autoresuscitation has not been reported.** The provision of cardiopulmonary resuscitation, as may apply to uncontrolled organ donation after cardiac death, may influence observation time. **However, existing evidence is limited and is consequently insufficient to support or refute the recommended waiting period to determine death after a cardiac arrest, strongly supporting the need for prospective studies in dying patients.** (emphases added)

This review was updated in 2018 [Hornby et al 2018] and again in 2023 [Zorko et al 2023]. It is interesting to compare that latest update with a 2011 review by Joffe and colleagues [Joffe et al 2011], because they reach opposite conclusions from essentially the same evidence. Joffe et al concluded that existing data failed to justify any particular "no-touch" threshold. They also raised serious concerns about conflicts of interest, "premortem interventions which can hasten death," and lack of informed consent; as a consequence, they called for a moratorium on DCD.

By contrast, Zorko and colleagues concluded that "[a] five-minute observation time is sufficient for controlled DCD (moderate certainty). An observation time greater than five minutes may be needed for uncontrolled DCD (low certainty)." [Zorko et al 2023] These recommendations were incorporated into the Canadian 2023 consensus-based clinical practice guideline for the determination of death, which established 5 minutes for controlled and 10 minutes for uncontrolled DCD as the official thresholds for Canada [Shemie et al 2023].

It is clear that "the devil is in the details," as the saying goes. In addition to the distinction between controlled and uncontrolled DCD, Zorko et al distinguished between case series (which

they called "observational studies") and reports of single extraordinary cases ("case reports"). The following table extracts from both papers (Joffe et al Table 3, Zorko et al Tables 1 and 2) cases with autoresuscitation times of 5 minutes or longer, arranged in order of autoresuscitation time.

Author	**Age**	**Minutes**	**Controlled / Uncontrolled**	**Case Report / Observational Study**
Letelier (1982)	80	5	Uncontrolled	Case report
Rosengarten (1991)	36	5	Uncontrolled	Case report
Frölich (1998)	67	5	Uncontrolled	Case report
MacGillvray (1999)	76	5	Uncontrolled	Case report
Abdullah (2001)	93	5	Uncontrolled	Case report
Spowage (2017)	66	5	Uncontrolled	Case report
Sypré (2021)	66	>5	Uncontrolled	Case report
Sukhyanti (2016)	25	~5-7	Uncontrolled	Case report
Mullen (2021)	18 mo	~6	Uncontrolled	Case report
Voelckel (1996)	55	7	Uncontrolled	Case report
Kuisma (2017)	"adult"	8	Uncontrolled	Observational
Quick (2020)	70	8	Uncontrolled	Case report
Mahon (2020)	79	~9	Uncontrolled	Case report
Ben-David (2001)	66	10	Uncontrolled	Case report
Vaux (2013)	63	10	Uncontrolled	Case report
Pasquier (2018)	63	~10	Uncontrolled	Case report
Monticelli (2006)	78	>10	Uncontrolled	Case report
Steinhorn (2021)	23 mo	~14	Controlled	Case report
Sharma (2020)	33	20	Uncontrolled	Case report

Not cited by Zorko et al (and after Joffe et al) is:

Sprenkeler (2013)	86	10	Uncontrolled	Case report

The conclusions of Zorko et al were based on (1) a strong methodological preference of observational studies over case reports, and (2) a tacit assumption that extraordinary uncontrolled cases carry no implications for the controlled setting. The main justification for the 5-minute recommendation for controlled DCD was that "[t]his evidence considers a large, multicentred observational study of 631 patients with continuous vital sign monitoring showing that the longest time to any autoresuscitation event was four minutes and 20 sec." [Zorko et al 2023 (p. 9)]

Several comments are in order.

1. All but one case in the table were indeed uncontrolled, and that was a 23-month-old toddler. It is reasonable to suppose that older children and adults have less potential for autoresuscitation than young children, which may be why Zorko et al felt justified in ignoring that one exception to the 5-minute threshold. On the other hand, there are so few

data for children and young adults that there is no basis whatsoever for speculating at what age the potential for autoresuscitation settles into the "adult" threshold.

2. "Evidence on autoresuscitation in pediatric patients is limited to case reports and two observational studies enrolling a total of 12 pediatric patients following WLSM [withdrawal of life-sustaining measures], including eight potential pediatric DCD patients.[26,31,40,41] Similarly, we did not identify any studies pertaining to the neonatal population or those with MAiD." [Zorko et al 2023 (p. 12)] [MAiD = "Medical Aid in Dying," a euphemism for euthanasia]

   Comment: The fact that so few pediatric patients have been studied systematically, yet two of the 19 cases in the above table with autoresuscitation times ≥5 minutes were young children, suggests that if a large observational study of children were to be undertaken, there is a very good chance that some patients would have autoresuscitation times ≥5 minutes. Therefore, in pediatrics a 5-minute threshold for controlled DCD is certainly unjustified, and, given the case of the 23-month-old reported by Steinhorn (2021), anything less than 15 minutes should be considered unjustified.

3. All but one case in the table were from single case reports. From a methodological standpoint, prospective observational studies make possible an estimate of the incidence of autoresuscitation after a specified interval of time, while case reports indicate merely that something is possible, with no information concerning its incidence. Zorko et al placed more weight on observational studies, but what we should be concerned with is the *possibility* of autoresuscitation after a given amount of time, not the incidence of it.

4. The largest observational study of withdrawal of life-sustaining measures (±DCD) comprised 631 patients across multiple institutions [Dhanani et al 2021]. There were 5 autoresuscitation events, with times between 1 minute and 4 minutes 20 seconds.

   Comment: 4 minutes 20 seconds is uncomfortably close to 5 minutes. If out of 631 cases, one was 4 minutes 20 seconds, who is to say that out of a different set of 631 cases there might not be one that was over 5 minutes, especially given that there are individual case reports of over 5 minutes? This question can be expressed in formal statistical terms, and it can be rigorously answered quantitatively: If 0 cases out of 631 had autoresuscitation after 5 minutes, what is the probability of autoresuscitation for the next patient after 5 minutes? This probability should then be compared with an acceptable probability of a false positive declaration of death. In other words, what is moral certainty, expressed quantitatively in terms of probabilities? Let us address this question first, then turn our attention to the specifics of the Dhanani et al study.

   Although bioethical opinion is notoriously all over the map on a wide variety of issues, as regards the degree of certainty for determining death, bioethicists have been uniquely of one mind. Consider the following quotations (in chronological order, emphases added):

   > [I]f an error occurred, it was our basic tenet that the sequence of clinical and laboratory events would be judged so that the error would ***always*** be made on the side of misdiagnosing a "dead" cerebrum as "alive." [Korein et al 1975 (p. 934)]
   >
   > In some respects, these criteria overlap and give added assurance that errors of omission ***will not cause lethal mistakes***.... [T]he chance of even temporary survival if the proposed clinical and EEG criteria are met for 30 minutes is small, and are [sic] ***infinitesimal*** if the confirmatory test is also met. [Walker et al 1977 (p. 985)]
   >
   > The criteria that physicians use in determining that death has occurred should: (1) ***Eliminate*** errors in classifying a living individual as dead, (2) Allow as few errors as possible in classifying a dead body as alive, … [President's Commission 1981 (p. 161)]
   >
   > Indeed, medical experts testified to the Commission that the risk of mistake in a competently performed ["brain-death"] examination was ***infinitesimal***. [President's Commission 1981 (p. 29)]

> By far the most important requirement for a criterion of death and for a test is to yield ***no*** false positives. Of secondary importance, the criterion and tests should produce few and relatively brief false negatives, … [Bernat et al 1981 (p. 391)]
>
> For the public to trust the pronouncements of medical doctors as to whether a patient is dead or alive, the criteria must be unambiguous, understandable, and ***infallible***. It is equally important to physicians that accurate, ***infallible*** criteria define death… Clear, ***infallible*** criteria allow us to assure families and society that one living person will not be intentionally or unintentionally killed for the sake of another. [Van Norman 1999 (p. 284)]
>
> Thus the whole-brain formulation provides a fail-safe mechanism to ***eliminate*** false-positive brain death determinations and assure the loss of the critical functions of the organism as a whole. [Bernat 2006 (p 39)]
>
> As a fundamental principle, moral abhorrence of making a false diagnosis of death with neurological criteria should be ***absolute***. This standard should persuade all doctors that strict adherence to testing that does not risk further injury to the patient and provides an ***infallible*** conclusion is mandatory. [Powner 2009 (p. 1587)]
>
> To avoid ***any*** false-positive BD declarations by the SBD [single brain death] exam, we adopted a cautious approach..." [Varelas et al 2011 (p. 548)]
>
> Because such whole brain measurements of function [techniques that assay cerebral blood flow or metabolism] may not be widely available and are expensive, clinical criteria aimed at a ***zero*** percent error rate of making an accurate diagnosis of brain death have evolved and undergone continuing refinement… brain death is a diagnosis that can ***always*** be correctly obtained, *if properly assessed*. (last, non-bold emphasis in original) [Schiff and Fins 2016 (p. R573)]
>
> We heartily agree … that public trust in brain death requires that there be ***zero*** false-positive determinations of death. [Lewis et al 2018 (p. 536)]
>
> The epistemic demands for declaring someone dead are high. So much hangs on declaring a human being dead—philosophically, religiously, socially, culturally, legally, and economically—that mistakes would need to be ***vanishingly rare*** and of little to no consequence when they do occur. Such is the case for traditional cardiopulmonary determinations of death. Such also ought to be the case for neurological determinations of death [as well as for DCD (my gloss)]. [Sulmasy 2019 (p. 476)].

Returning to the large Dhanani et al study of controlled DCD on which Zorko et al largely based their recommendation of 5 minutes, 0 false positives out of 631 cases would indeed be an impressive statistic for diagnosing a disease, but is it for all intents and purposes "infinitesimal"? Of course, 0 out of 631 does not prove a 0% false-positive risk. As the title of a biostatistics paper catchily put it: "If nothing goes wrong, is everything all right?" [Hanley and Lippman-Hand 1983]

The zero-numerator problem has been addressed by at least two statistics papers, each using a different methodology but yielding results in the same ballpark. My own paper, employing a Bayesian methodology, showed that for a study in which there were 0 errors out of N cases fulfilling a given criterion, given no relevant information but that, the risk of false-positive error is approximately 1/(N+2), and the risk of at least one false-positive among the next (N+1) cases is 50% [Shewmon 1987]. The paper by Hanley and Lippman-Hand [1983], endorsed by Nouraei [2009], approached the question in terms of confidence intervals (CI): for false positives, the 95% CI is 0 to 3/N, the 99% CI is 0 to 4.6/N, and the 99.9% CI is 0 to 6.9/N. Applied to the Dhanani et al [2021] study with N=631, these methodologies yield:

- absolute false-positive risk: $1/633 \approx 0.16\%$

- risk of at least one false-positive in the next 632 cases is ≈ 50%
- false-positive 95% CI: 0 to 3/631 ≈ 0.48%
- false-positive 99% CI: 0 to 4.6/631 ≈ 0.73%
- false-positive 99.9% CI: 0 to 6.9/631 ≈ 1.1%

No matter what methodology you prefer, the risk of false-positive error is nowhere near "infinitesimal." A new drug that caused no serious side effects in a prospective, randomized, controlled study of 631 patients (analogous to controlled DCD), but which was associated with death in 18 non-study patients with comorbid factors of possible but unclear relevance (analogous to uncontrolled DCD), would never be approved without a new safety study orders of magnitude larger. Moral certainty of no potential for autoresuscitation should be no less certain prior to organ removal.

A quotation from Pope Pius XII, taken from [Eble 2024] is relevant here: "Sometimes moral certainty is derived only from an aggregate of indications and proofs which, taken singly, do not provide the foundation for true certainty, but which, when taken together, no longer leave room for any reasonable doubt on the part of a man of sound judgment." [Pius XII 1942] Such an aggregate of proofs is lacking for DCD.

5. The largest observational study of terminated CPR comprised 840 patients [Kuisma et al 2017]. There were 5 autoresuscitation events, with CPR lasting 12 to 31 minutes and time from CPR cessation to autoresuscitation ranging from 3 to 8 minutes. The authors therefore recommended (and the Canadian clinical practice guideline endorsed) a 10-minute threshold for uncontrolled DCD. Applying the same statistical formulae as above:
   - absolute false-positive risk: 1/842 ≈ 0.12%
   - risk of at least one false-positive in the next 841 cases is ≈ 50%
   - false-positive 95% CI: 0 to 3/840 ≈ 0.36%
   - false-positive 99% CI: 0 to 4.6/840 ≈ 0.55%
   - false-positive 99.9% CI: 0 to 6.9/840 ≈ 0.82%

   The fact that case reports of uncontrolled DCD have included autoresuscitations up to 20 minutes [Sharma 2020] proves that these false-positive rates are no mere abstract theory, and that the 10-minute threshold is inadequate.
6. Not included in any of these papers was the report of a woman who was found to have pulsation in the aorta and renal arteries after being declared dead and her abdomen opened in a DCD protocol. She developed transient agonal respirations. The operation was abandoned and she was declared dead a second time 17 minutes after the first declaration [Bao and Bao 2021].
7. Also not included was the horrifying report of a woman declared dead in a hospital, who later at her wake knocked from within the coffin to be let out. Whether this was an instance of autoresuscitation or a misdiagnosis of circulatory arrest we will never know [Thurston and Schofield 2023].
8. Concerning the special issue of the *Canadian Journal of Anesthesia* devoted to the clinical practice guideline and related articles, e-published on 5/2/2023 (in which a no-touch period of 5 minutes was recommended for controlled DCD and 10 minutes for uncontrolled DCD):
   a. Consensus is easy to achieve when only like-minded experts are invited.
   b. Although there was only "moderate certainty in evidence" for controlled DCD and "low certainty in evidence" for uncontrolled DCD, the two no-touch times received a "strong recommendation."
   c. In the Zorko et al study, a risk of bias assessment was conducted on the seven observational studies. This is ironic, since there seems to have been no consideration whether bias might have influenced the authors' recommendation of no-touch time based on the reviewed data, a time brief enough for organ viability and successful transplants. The first author of [Hornby et al 2018], Laura Hornby, "is the Project Manager for a research program in deceased organ

donation, funded by the Canadian Institutes of Health Research." She was the third author of the Zorko et al study, of which another coauthor (Shauna Matheson) was affiliated with Legacy of Life, Nova Scotia's organ and tissue donation program. The study was "made possible through a financial contribution from Health Canada through the Organ Donation and Transplantation Collaborative." The 2023 Clinical Practice Guideline [Shemie et al 2023], which formally recommended the 5- and 10-minute times for controlled and uncontrolled DCD, was funded through the same source.

By contrast, the Joffe et al review, which recommended a moratorium on DCD, was unfunded.

[y] According to my proposed semantic bifurcation (see endnote *s*) [Shewmon 2010], such donors would be "deceased" though not ontologically "deanimated."

[z] The confluence of such concerns motivated Joffe and colleagues to call for a moratorium on donation after circulatory death [Joffe et al 2011].

[aa] Even hearts have begun to be successfully transplanted after no autoresuscitation occurred during 5 minutes of circulatory arrest following withdrawal of extraordinary means of life support [Chew et al 2019; Anguela-Calvet et al 2021; Joshi et al 2023; Siddiqi et al 2023]. Other alternatives to "brain-dead" donors, not known at the time of the *Apologia*, include xenotransplantation from genetically modified pigs [Montgomery 2022; Pierson 2022; Monaco 2023; Neergaard 2023] and in the near future the *in vitro* growing of new organs and tissues from patients' own stem cells [Fishman et al 2014; Griffith and Harkin 2014; Teoh et al 2015; Annesini et al 2017; Klak et al 2020; Kim et al 2020; Miller 2022]. If it hadn't been for the ease of obtaining organs from "brain-dead" donors, these ethically less problematic solutions would have been researched earlier and more intensely.

[bb] The article was published four years later in *Aletheia* 7:287-320, 2001.

[cc] A full article on these cases was subsequently published as [Shewmon et al 1999].