

ALLEGED AWAKENINGS FROM PROLONGED COMA AND BRAIN DEATH AND DELIVERY OF LIVE BABIES FROM BRAIN-DEAD MOTHERS DO NOT NEGATE BRAIN DEATH*

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The topic assigned to me for this presentation is ‘alleged awakenings from prolonged coma and brain death and delivery of live babies from brain-dead mothers do not negate brain death’. I will divide that topic into three sections: 1. Awakening from brain death. 2. Awakening from prolonged coma. 3. Delivery of live babies from brain-dead mothers.

I start with the premise that there exists a clinically definable state in which formerly functioning individuals suffer irreversible destruction of cerebral hemispheres and brainstem (i.e., loss of all brainstem responses), such that they do not have, and can never achieve, awareness of self or environment. This state has been given several names: It has been called ‘irreversible coma’, ‘brain death’ or, as I will attempt to show in this presentation, just ‘death’. When such a state is identified, electrophysiologic and metabolic tests demonstrate no functioning intracranial activity. For example, a glucose PET scan shows no metabolic activity [1], an angiogram shows no blood flow.

The clinical criteria for the neurological determination of death are well-established [2]. These clinical criteria demand knowledge that the etiology of brain damage is irreversible (i.e., that there is no possible reversible condition capable of mimicking neurological death), that the body is totally unresponsive with bilateral absence of motor responses, (excluding spinal reflexes) and that all brainstem reflexes are absent including respiration, usually proved by an apnea test. Two examinations, usually several hours apart, assure irreversibility. In most but not all countries, meeting these *clinical* criteria is sufficient to pronounce death. In some countries confirmatory laboratory tests may be required. These include electrodiagnostic, metabolic or vascular tests. Dr. Wijdicks, in his 2001 book entitled *Brain Death*, has detailed the criteria for individual European countries [3].

* The views expressed with absolute freedom in this paper should be understood as representing the views of the author and not necessarily those of the Pontifical Academy of Sciences. The views expressed in the discussion are those of the participants and not necessarily those of the Academy.

The first question is does one ever awaken from 'brain death'? I believe the short answer is no. Interestingly, although there is to my knowledge no instance of a body meeting the clinical criteria for brain death ever awakening, there are several instances in the literature in which patients unexpectedly regain spontaneous circulation following a cardiac arrest after resuscitation has been discontinued and the patient pronounced dead (cardiac death). This recovery has been called the Lazarus phenomenon. At least 18 such cases were reported in a review in 1998; some of these patients actually recovered consciousness [3].

Although the recovery from correctly diagnosed brain death has never been reported, prolonged survival of organs other than the brain has been achieved using artificial respiration and pressor agents. In 1998, Dr. Shewmon [4] described 175 such instances; in 7 instances, peripheral organs survived longer than six months and in another instance 20 years [5]. This unique instance was a 4-year-old child who appeared to meet the criteria for brain death after an episode of bacterial meningitis. Twenty years later at autopsy 'no neural elements were recognizable at the light microscopic level on any of the stains or with immunohistochemical markers' [5]. Many experts believe that (perhaps most) of the patients reported by Dr. Shewmon may not have met the clinical criteria for brain death and even in the child there is some question. There are, however, other reports in the literature that indicate that with major efforts directed at maintaining respiration and hemodynamics, one can keep peripheral organs alive for several days [6,7]. Nevertheless, none of these patients ever recovers.

Dr. Shewmon, who does not believe that a brain-dead body is actually dead [8,4], chides neurologists who accept the concept for using language that often suggests they themselves are not certain. A cardiologist who pronounces a patient dead does not say that the individual is 'cardiac dead', but simply that he/she is dead. We should use the same language. Language such as that quoted by Dr. Shewmon in his written presentation to this meeting ('children who are brain-dead can be kept alive by artificial means for a long period of time', 'the bodies of two [brain-dead] lived on until the 10th and 16th day', 'all of the [brain-dead] patients died within 24 hours') must be avoided if we are to convince the public that a brain-dead body is dead.

For the first part of this presentation, I conclude that if the proper clinical criteria for brain death are applied, no patient recovers consciousness and although prolonged survival of somatic organs may be possible, it is rare.

The second question is do patients awaken from 'prolonged coma'? If one defines coma as eye-closed unconscious without sleep-wake cycles or periods

of eye opening, I know of no instance of a patient awakening from that state. Actually, prolonged coma is quite rare, almost all patients transitioning to a persistent vegetative state within a matter of a few weeks. For patients in the vegetative state and those minimally conscious the situation is different.

The Royal College of Physicians of the UK guidelines have defined the *vegetative state* as occurring in an individual who has no evidence of awareness of self or environment at any time, no response to visual, auditory or noxious stimuli of a kind that suggest volition or conscious purpose, no evidence of language comprehension or of meaningful expression, with cycles of eye closure and eye opening. Hypothalamic and brainstem functions may be sufficiently preserved to insure maintenance of respiration and circulation [9]. The *persistent vegetative state* is defined as a vegetative state lasting more than one month. The *permanent vegetative state* is defined as a vegetative state persisting for one year after a traumatic brain injury or three months after a nontraumatic brain injury. Using the three month and one year definitions, an occasional patient does recover from the so-called *permanent vegetative state* [10, 12]. Such patients may emerge from the vegetative state to the minimally conscious state (see below). Thus, patients believed to be vegetative require expert periodic re-evaluation. The re-evaluation may include not only the clinical examination, but also laboratory techniques such as functional MRI [13]. It may even include trials of drugs [14] and techniques [15, 16] that have been reported to awaken some minimally conscious patients.

The *minimally conscious state* [17] describes a patient with limited but clearly discernible evidence of self or environmental awareness on a reproducible or sustained basis. Such evidence includes one or more of the following behaviors: The following of simple commands; gestural or verbal yes or no responses (independent of accuracy); intelligible verbalization; purposeful behavior (contingent relationship to environmental stimuli). Patients may recover from the minimally conscious state after several years [17]. The mechanism of that recovery is uncertain, but could include axonal regrowth [15] or neurogenesis [19].

For the second part of this presentation, I conclude that patients do not awaken from prolonged coma but may recover from the vegetative or the minimally conscious state.

The third question addresses delivery of live babies from brain-dead mothers. Pregnant women suffering brain death are uncommon. In one series from a transplant center, of 252 brain-dead women of childbearing age, only seven were pregnant; another four were in the early postpartum

state [20]. However, there are several reports of brain-dead pregnant women whose fetus and organs were maintained for as long as 117 days resulting in delivery of a viable and apparently normal infant [21-23]. Whether all of these women actually met the clinical criteria for brain death is unclear, but it is likely that at least some of them did. Thus, for the third part of the presentation, I conclude that somatic survival in pregnant women who are either dead or vegetative is possible for some individuals in that viable babies who appear to be normal can be delivered. Maintaining the body of the mother is not easy and it is not clear if there are any long-term effects on the infant.

One fact that is important to recognize is that death is not an event, but a process. At the time a heart stops beating (cardiac death), the rest of the cells of the body are still living. Five to ten seconds after the heart stops the individual loses consciousness. However, at that point, neurons are still alive. After about four minutes, hippocampal neurons and Purkinje cells begin to die. Some evidence suggests that some neurons can be successfully cultured from the brain of individuals two to eight hours after death has been pronounced [24]. Other organs survive longer, often many hours. It is said that hair and nails grow for days after death. Thus, death does not occur at a moment in time, but only over hours or perhaps even days. The physician can be certain that death has occurred, but cannot define exactly when.

Addendum

I have listened to the presentations of my colleagues with great interest. I do not consider myself an expert on the topic of brain death. I learned much from my colleagues and based on their presentations, as well as my own experience and reading, I have reached the following conclusions:

1. *All death is brain death.* If the brain dies, but other organs are preserved, that individual is dead. If the brain lives, but other organs have died, that individual is alive.

2. *Death is a process.* The process begins when the integrative functions of the entire brain and the brainstem fail. The process ends when every cell in the entire body is dead. The damage to the brain may be primary (for example, head injury or brain hemorrhage), or secondary (for example, loss of brain blood flow after cardiac arrest).

Death is pronounced during the process when irreversibility is established but not all cells are yet dead. If it is true that hair and nails grow for days after death, waiting for every cell to die would be excruciating and monstrous.

3. When the neurologist appropriately uses the clinical criteria to establish brain death, the diagnosis of death is certain. There have been no documented exceptions. When the cardiologist announces cardiac death, the diagnosis is less certain. Many documented cases of patients pronounced dead after failure of cardiac resuscitation have subsequently been discovered to be alive and a few have actually recovered consciousness (Lazarus phenomenon).

4. Technology can preserve the organs of the dead person (one appropriately pronounced dead by neurologic criteria) for a period of time, usually only hours to days, sometimes longer. Nevertheless, that individual is dead.

5. If the phenomenon of 'heart-beating death' defies our common sense perception and is counterintuitive, so is the fact that the Earth is not flat. The history of science and medicine contains many discoveries that are contrary to our perceptions and are counterintuitive. One of the tasks of physicians and scientists is to educate the public concerning these discoveries. With respect to the concept that all death is brain death, the task may be difficult, but we are obligated to pursue it.

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