

THE HISTORICAL EVOLUTION OF BRAIN DEATH FROM FORMER DEFINITIONS OF DEATH: THE HARVARD CRITERIA TO THE PRESENT*

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Throughout the ages, *death* occurred when breathing ceased, but with the invention of the stethoscope in the early 1800s, loss of the heartbeat became the defining event (Jennett, 2001). The Fourth Edition of Black's Law Dictionary, the definitive treatise of the law in the United States, published in 1951, defined death as the 'cessation of life, defined by physicians as a total stoppage of the circulation of the blood...'. End of life determination was simple, as there were no reliable techniques for resuscitating a non-beating heart and ventilating a breathless patient. Then, in the 1950s and 60s, came resuscitation and ventilation. A heart that stopped could be restarted, and machines could breathe for the patient, which created a situation where patients with no cerebral function were sustained artificially, often for long periods of time. The concept of brain death was thus created by medical progress or, as eloquently stated by Jennett, was 'an artifact of nature resulting from the capacity of medical technology to prolong and distort the process of dying'.

In 1968, the Ad Hoc Committee of the Harvard Medical School, a group of distinguished clinicians and neuroscientists set out to define 'irreversible coma as a new criteria for death'. They aimed to establish criteria, whereby irreversible coma indicated brain death, and therefore, somatic death, and provided two reasons for their efforts. The major one was the burden on patients, their families, and hospitals, whose beds were being occupied by patients with no chance of recovery. The second was the need for a new definition of death, given the advances in organ transplantation. The Harvard Criteria is summarized in Table 1.

* 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.

TABLE 1.

<u>Harvard Criteria, 1968</u>	
1.	<u>Deep</u> coma/no withdrawal to painful stimuli
2.	Arreflexia (cranial and spinal)
3.	Apnea (disconnect from ventilator for 3 minutes)
4.	Flat Electroencephalogram (EEG)
5.	Exclusion of hypothermia and drugs
6.	Repeat above evaluation in 24 hours

The patient had to be in 'deep coma'. Coma is 'unrousable unresponsiveness', from which the patient cannot be awakened, and 'deep coma' is when a comatose patient is without spontaneous breathing, doesn't withdraw reflexively from painful stimuli, has no cranial reflexes, and a flat EEG. The 'Apnea Test' (defined in detail at this meeting by Professor Ropper) required disconnection from the ventilator for three minutes without the start of spontaneous breathing. In 24 hours, if the above criteria remained, and hypothermia and sedating drugs were ruled out, brain death was established.

In 1971, two neurosurgeons (Mohandas and Chou) published the 'Minnesota Criteria'. It was similar to the Harvard Criteria, except that the EEG was omitted, the repeat examination was at 12 rather than 24 hours, and the ventilator discontinuation was 4, rather than 3 minutes. But, the most important difference from the Harvard Criteria was the necessity for the patient to have an 'irrefutable intracranial lesion', in addition to the signs of brain death.

In 1976, the United Kingdom Code (Conference 1976a; 1976b) eliminated the need for a repeat exam, and required a specific level of CO₂, rather than simply time, to determine that the Apnea Test failed to re-establish respirations.

The U.S. Collaborative Study (1997) criteria reintroduced a flat EEG and the repeat exam (this time at 30-60 minutes), but dropped the Apnea Test. For the first time, absent cerebral circulation was added as an optional test.

The U.S. President's Commission (1981) brought back the Apnea Test and required a repeat exam, with cerebral blood flow again added only if needed to make the determination.

TABLE 2.

<u>Pediatric Ad Hoc Task Force, 1987</u>	
Same as adult, EXCEPT:	
1.	EEG and blood flow study recommended in infants less than 1 year of age
2.	Repeat exam dependent upon age:
	7 days–2 months: Two exams and two EEGs, 48 hours apart
	2 months–1 year: As above, but 24 hours apart, OR no repeat exam or EEG in absence of initial blood flow
	1 year and above: Two exams, 12–24 hours apart; EEG and blood flow optional

All the above tests dealt with adults. The pediatric criteria (Guidelines, 1987) had repeat exams depending upon the patient's age, and the first exam could not be done before the seventh day. These are summarized in Table 2.

The highly influential American Academy of Neurology Criteria (1995) provided very strict testing details for the Apnea Test, including delivery of 100% oxygen to prevent the test itself from causing further harm to the brain. EEG and blood flow were, again, not mandatory. The Canadian Neurocritical Care Group (2000) essentially endorsed the American Academy of Neurology Criteria.

Eighty countries share the same criteria used for establishing the loss of cranial reflexes (Wijdicks, 2006). The major differences are in the performance of the Apnea Test, the number of physicians required to confirm the diagnosis, and the need for, and type of, confirmatory tests (electroencephalography, cerebral blood flow, and evoked potentials). The basic criteria are graphically depicted in Wijdicks' pyramid (Figure 1), published in 2004, which also includes the pediatric criteria.

I cannot overemphasize, however, that we *must* adhere to the applicable governing laws wherever the brain death determination is made. As mentioned, these vary somewhat, and despite the guidelines and criteria from commissions and specialty societies, our actions must always conform to the applicable law.

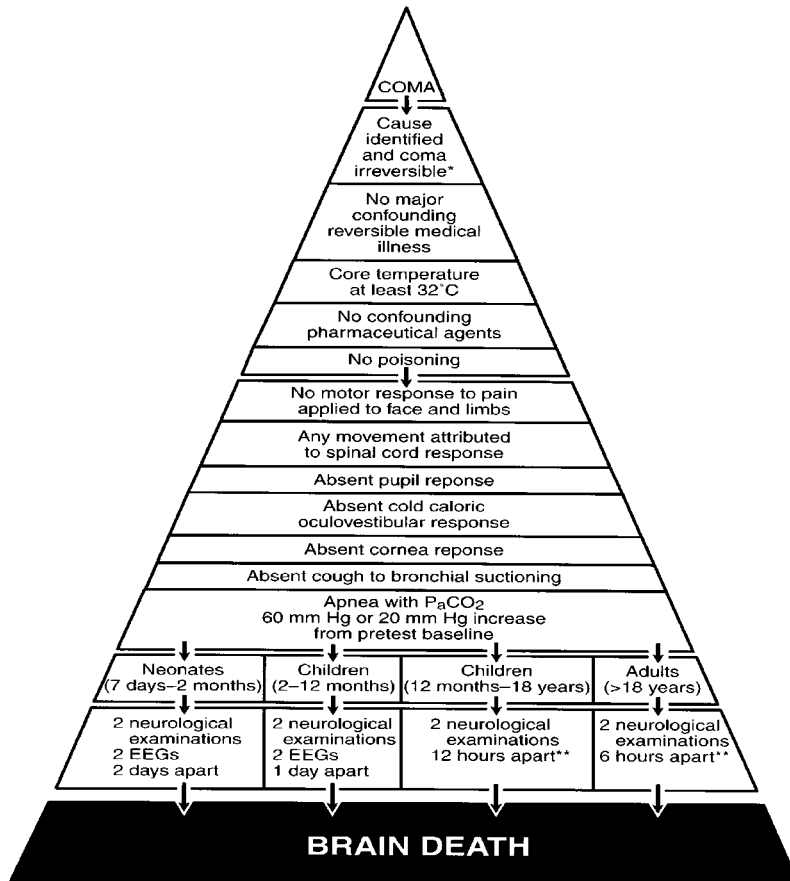


Figure 1. (From Wijdicks, 2004).

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