

**FAST FACTS AND CONCEPTS #115  
DECLARING BRAIN DEATH: THE NEUROLOGIC CRITERIA**

**Amal Puswella, Mike DeVita, Robert M Arnold MD**

**Background** This *Fast Fact* reviews the details of declaring death based on neurological criteria. In 1980, the Uniform Determination of Death Act (UDDA) was created which stated that “An individual who has sustained either 1) irreversible cessation of circulatory and respiratory function, or 2) irreversible cessation of all functions of the entire brain, including the brainstem, is dead. A determination of death must be made with accepted medical standards.” The UDDA did not define “accepted medical standards,” and so the American Academy of Neurology published guidelines in 1995, and updated them in 2010. Despite these national guidelines, there is still considerable variability in local institutional guidelines.

**Determining death by neurologic criteria involves two steps:**

- **Step 1:** Rule out reversible causes of unconsciousness: sedative medication, neuromuscular blocking agents or hypothermia.
- **Step 2:** Rule out the presence of cortical activity and brainstem reflexes using clinical exams/tests. *The exact tests done may vary by institution and one should check with their own institution’s policies. Brain death exams are typically completed by neurologists, neurosurgeons, and critical care physicians.* For a person to be dead by brain death, typically all of the following tests must show lack of brain function:
  - No spontaneous movement and no movement in response to painful stimuli (movement due to spinal reflexes are acceptable).
  - No seizures, decerebrate or decorticate posturing, or dyskinetic movements.
  - Absent cranial nerve reflexes including pupillary response to light, corneal reflexes, oculoccephalic reflex, caloric response, facial movement to a noxious stimulus, and gagging and cough with suctioning.
  - *Caloric testing* is done by first ensuring the auditory canal is clear and the tympanic membranes are intact. The head is elevated to 30°, 50 ml of ice water is slowly infused into the canals, and the eyes are observed for one minute. The normal response in an awake patient is tonic deviation of the eyes toward the cold stimulus followed by nystagmus back to the midline; the normal response in a comatose patient with an intact brainstem is tonic deviation of the eyes toward the cold stimulus without nystagmus; in brain death, the eyes do not move. Both ears must be tested with an interval of several minutes in between.
  - **Note:** At some institutions other clinical tests are done before a formal *apnea test* (see below). For example, some require documentation of no vagal nerve activity – an atropine test is used. The patient is given 2 mg IV atropine. In the dead patient, the parasympathetic outflow is non-functioning and the heart rate will not change (<10 beats/minute).
  - Absence of central respiratory drive is assessed using the *apnea test* to see if a rise of CO<sub>2</sub> provides a stimulus to breathe. The patient is ventilated with 100% oxygen for 10-20 minutes and a baseline blood gas is obtained. The ventilator is then removed while 100% oxygen is delivered; O<sub>2</sub> saturation is continuously assessed. A follow-up ABG is done after 5-10 minutes. If the PaCO<sub>2</sub> rises past 60mm Hg (or >20 mm Hg above baseline), and no breathing efforts are observed, the respiratory center is not functioning. The test should be aborted if the patient develops hypoxemia (also indicates no respiratory drive), hypotension, or arrhythmias.

**Adjunctive or confirmatory tests** are needed in complex clinical situations such as uremia or hepatic encephalopathy, when apnea testing cannot be performed, when the primary brain insult is infratentorial, or if required by the local institutional brain death policy.

- Electroencephalogram: must be isoelectric, which is difficult in the ICU due to electrical artifact).
- Transcranial Doppler: intracranial arteries demonstrate either absence of diastolic flow, or small systolic peaks.
- Somatosensory Evoked Potentials: bilateral median nerve stimulation demonstrates an absence of the N20-P22 response.

- Intracranial Pressure: sustained, elevated ICP within 10 mmHg of mean arterial pressure.
- Tests of cerebral blood flow: if there is no cerebral blood flow then there is no brain function and death may be determined based on this test alone. Specific tests include cranial radionuclide angiography and conventional contrast angiography.

## References

1. Wijdicks E, Varelas P, Gronseth G, et al. Evidence-Based guideline update: Determining brain death in adults. Report of the quality standards subcommittee of the American Academy of Neurology. *Neurology* 2010; 74:1911-1918.
2. Greer D, Varelas P, Haque S, et al. Variability of brain death determination guidelines in leading US neurologic institutions. *Neurology* 2008; 70:284-289.
3. Plum F, Posner J. *The Diagnosis of Stupor and Coma*. 3<sup>rd</sup> Edition. New York, NY: Oxford University Press; 1982: pp57-61, 313-320.
4. Van Norman G. A matter of life and death: what every anesthesiologist should know about the medical, legal, and ethical aspects of declaring brain death. *Anesthesiology*. 1999; 91(1): 275-287.
5. Certification of Death in Adults Policy: 5108. University of Pittsburgh Medical Center, Pittsburgh, PA; 2000.

**Version History:** This *Fast Fact* was originally edited by David E Weissman MD and published in May 2004. Re-copy-edited in April 2009; then it was copy-edited again by Sam Maiser MD in June 2015 in which references 1 and 2 were added and incorporated into the text.

**Version History:** This *Fast Fact* was originally edited by David E Weissman MD and published in June 2004. Re-copy-edited in April 2009; web-sites updated; revised again in July 2015 by Sarah Friebert MD.

**Fast Facts and Concepts** are edited by Sean Marks MD (Medical College of Wisconsin) and associate editor Drew A Rosielle MD (University of Minnesota Medical School), with the generous support of a volunteer peer-review editorial board, and are made available online by the [Palliative Care Network of Wisconsin](#) (PCNOW); the authors of each individual *Fast Fact* are solely responsible for that *Fast Fact's* content. The full set of *Fast Facts* are available at [Palliative Care Network of Wisconsin](#) with contact information, and how to reference *Fast Facts*.

**Copyright:** All *Fast Facts and Concepts* are published under a Creative Commons Attribution-NonCommercial 4.0 International Copyright (<http://creativecommons.org/licenses/by-nc/4.0/>). *Fast Facts* can only be copied and distributed for non-commercial, educational purposes. If you adapt or distribute a *Fast Fact*, let us know!

**Disclaimer:** *Fast Facts and Concepts* provide educational information for health care professionals. This information is not medical advice. *Fast Facts* are not continually updated, and new safety information may emerge after a *Fast Fact* is published. Health care providers should always exercise their own independent clinical judgment and consult other relevant and up-to-date experts and resources. Some *Fast Facts* cite the use of a product in a dosage, for an indication, or in a manner other than that recommended in the product labeling. Accordingly, the official prescribing information should be consulted before any such product is used.