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, oculocephalic 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 CO₂ 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; O₂ saturation is continuously assessed. A follow-up ABG is done after 5-10 minutes. If the PaCO₂ 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