

Death: Determination by Neurological Criteria (DDNC)

Background

In 1981, a Presidential Commission authored the Uniform Determination of Death Act (UDDA) which conceptually validated the concept of brain death as a second mechanism of death.¹ Brain death has also been referred to as death by neurological criteria (DNC) in an attempt to remove any potential confusion in terminology. Historically, some have misconstrued that brain death may refer to the death of the brain rather than death of the person themselves as it was intended. DNC will be the preferred term of this policy.

Subsequent to the publication of the UDDA, DNC has been recognized as a valid mechanism of death, in some manner, by every state in the country, either by statute, or as in Massachusetts, by case law. Additional support has come from the American Bar Association, the American Medical Association, the National Council of Commissioners on Uniform State Laws and most recently by a Presidential Council on Bioethics.² DNC has also been recognized at some level in more than 80 other countries.³ No court has ever rejected the concept of DNC on medical grounds. No patient declared brain dead by accepted criteria has ever been subsequently found to have been alive subsequent to the time that DNC was determined.⁴

The means by which DNC is determined has been left to the purview of individual institutions. Although guidelines have existed, there has been great variability in their inter-institutional makeup.^{5,6} Since 1988, Lahey Clinic has maintained a policy recognizing the validity of brain death or death by neurological criteria (DNC) and the means by which it can be determined (determination of death by neurological criteria or DDNC). The determination of death by cardiopulmonary criteria and related issues are addressed in Lahey Clinic policy 5158 Organ Retrieval from Patients Declared Dead Using Cardiopulmonary Criteria (Non Heart Beating) http://www.lahey.org/Pdf/Ethics/PDF_Policy/5158.pdf

For the purposes of this policy, DNC is defined as an individual who has irreversibly lost function of their entire brain as determined clinically, and when appropriate, by ancillary testing. For purposes of this document, determination of DNC (in the patient) is distinguished from documentation of DNC (in the medical record). It is critical to the integrity of the Lahey Clinic and public confidence that this policy be followed explicitly in all cases.

Policy

Who can perform the DDNC evaluation?

All parts of the DDNC, with the exception of the apnea test, must be performed or eye witnessed by an attending Neurologist or Neurosurgeon. Neurology or Neurosurgery house officers or mid-levels may perform DDNC testing only with direct visual supervision by a senior Neurologist or Neurosurgeon. The apnea test may be performed by any physician or respiratory therapist who is experienced with the procedure. If performed by a respiratory therapist, it should be witnessed by an experienced staff physician with a critical care, neurological or neurosurgical background.

Any physician involved in the determination of DNC should not benefit, or be perceived to benefit, directly or indirectly from the donation of that patient's organs, should organ donation occur. To avoid any potential perception of conflict of interest, no individual involved in the care of the patient, particularly in the determination of DNC, should initiate organ donation discussion with

family members. Exceptions to this would include introduction of the subject by family members or proxy agent, or the existence of an authentic, premorbid document expressing the patient's wish to be an organ donor. When DNC is anticipated, the attending physician or their surrogate should promptly alert the NEOB. No representative of the NEOB however, should approach the patient's family or proxy agent until authorized to do so by the attending physician or their surrogate. Once the subject of organ donation is introduced, Lahey personnel involved in the care of the patient are at liberty to discuss organ donation with the family when appropriate. The NEOB representative should be sensitive to all aspects of the DDNC process and refrain from coercion directed towards patient's family or medical personnel involved in DDNC, which remains solely within the purview of licensed physicians.⁷

The Lahey Clinic does not possess the resources to adequately determine DNC in individuals less than 16 years of age. Should an individual less than 16 suspected of being DNC arrive in the Lahey Clinic Emergency Room, every attempt should be made to transfer that individual to an institution with adequate pediatric neurology and/or neurosurgical staffing to allow for an accurate (and timely) diagnosis to occur.

Establishing the cause of DNC

Determination of irreversible brain injury is integral to the DDNC. Identification of etiology of DNC is in turn integral to the determination of irreversibility. Attempts should be made to establish the reason for suspected DNC in all cases including appropriate and comprehensive diagnostic procedures as indicated. These tests may include but are not limited to brain imaging, ascertainment of core body temperature, toxicology and metabolic screens, and CSF examination. In certain cases, determination of etiology may not be possible. DDNC is not precluded by a failure to ascertain its cause. In such cases however, a second DDNC examination done at least 24 hours after the first and a supportive ancillary test is mandatory. If it is apparent the two or more clinical examinations pertaining to DNC will be performed, it would be acceptable to perform the apnea test component of these clinical examinations on only the last of these determinations.

What conditions may interfere with the DDNC?

Complicating medical conditions can confound the determination of DNC and should be considered and excluded beyond reasonable doubt before final determination. Such conditions include severe electrolyte, acid-base, or endocrine disturbances; hypothermia (core temperature, < 36°C), hypotension (< 90 mm Hg systolic), drug or other intoxication, and neuromuscular failure induced by disease or pharmacologic agents. Alterations in metabolic parameters do not preclude the determination of death by neurological criteria if deemed inconsequential to the patient's absent brain function. If there is any doubt about confounding drug effects in DNC, five half lives of the drug in question should elapse before DNC is declared.

When can death DNC be determined?

There is no adequate evidence yet reported that determines the length of observation time necessary to ensure accurate DDNC.⁴ Timing, as it pertains to DDNC in adults, is therefore left to the discretion of the physician making that determination. When the etiology of DNC is certain and sufficient, a single neurological examination including the apnea test is sufficient for DDNC. If causation of DNC is uncertain, the recommended course of action for DDNC is outlined above.

What are the clinical criteria necessary for DDNC and what are the methods by which they are fulfilled?

The foundation of DDNC is the fulfillment of the clinical criteria which include the determination of unresponsive coma, the absence of brainstem reflexes, and the absence of ventilatory drive in response to an adequate CO₂ challenge. The means by which to make these determinations are as follows.⁴

1. The patient must demonstrate no evidence of higher brain function as determined by their unresponsive and unarousable state in response to verbal and tactile stimuli, the patient being by all appearances devoid of awareness of the world around them (unresponsive coma).
2. Reversible causes of depressed brain function as contributing factors should be ruled out. (see above).
3. **The neurological examination for the determination of DNC:** The patient must demonstrate no evidence of brain or brainstem function as evidenced by absence of all of the following indicators:
 - A. Spontaneous or reflex eye opening.
 - B. Facial movement in response to a noxious stimulus (deep pressure on nail bed, supraorbital ridge, temporomandibular joint, or styloid process).
 - C. Pupillary responsiveness to light or ciliospinal stimulus with pupils in the mid to dilated (typically 4-9mm) position utilizing a magnifying glass as necessary.
 - D. Ocular movement in response to an appropriately performed head movement (Doll's head/oculocephalic reflex) and if absent, confirmed by caloric stimulus (oculovestibular reflex)(50 cc of ice water applied to a visually intact tympanic membrane with 1 minute of observation and a 5 minute interval between sides).
 - E. Corneal reflex bilaterally.
 - F. Gag reflex or coughing in response to pharyngeal or tracheal stimulation.
 - G. Limb movement in response to noxious head and neck stimuli. Limb movement either spontaneous or in response to stimuli delivered below the neck that are considered to be reflexive and originating from spinal cord do not preclude DDNC⁸..
4. **Apnea test:** The patient must demonstrate absence of ventilation in response to an adequate CO₂ stimulus (apnea test)
 - A. Prior to commencement of the apnea test, the patient should be normotensive (systolic pressure > 100 mm Hg), euvoletic, eucapnic (PCO₂ of 35-45 mm Hg), with a normal PaO₂.
 - B. Preoxygenate the patient for > 10 minutes with 100% O₂ to a PaO₂ of > 200 mm Hg.
 - C. Maintain patient on continuous blood pressure and O₂ saturation monitoring.
 - D. Reduce ventilator rate to 10/min and PEEP to 5 cm H₂O.
 - E. Obtain baseline blood gas to establish that O₂ saturation is >95% and PCO₂ is between 35-45 mm Hg.
 - F. Disconnect patient from ventilator.
 - G. Preserve oxygenation by delivering 100% O₂ at 6L/min near but not below the end of the endotracheal tube.
 - H. Observe for ventilatory movements for 8-10 minutes.
 - I. At that time obtain a second blood gas – the apnea test is considered positive if PCO₂ is greater than 60 mm Hg or increases by more than 20 mm Hg over baseline in the absence of ventilatory movements.

- J. If the PCO₂ has not risen adequately after 8-10 minutes, a repeat arterial blood gas can be performed if the patient's blood pressure and oxygen saturation remain adequate.
- K. Abort apnea test if systolic blood pressure falls to less than 90 mm Hg or O₂ saturation is < 85% for > 30 seconds.
- L. The apnea test may be retried with a T-piece, CPAP of 10 cm H₂O and 100% O₂ at 12 L/min.
- M. Mechanical ventilation should be restored once a positive result is obtained, if ventilatory movements are observed, if the patient is a potential organ donor, if the family requests closure prior to the withdrawal of the endotracheal tube, or if test completion is precluded by hypotension, bradycardia, arrhythmia or other unforeseen complications.
- N. If the test is aborted prior to completion, a confirmatory test is mandatory.

What are some of the confounding factors potentially interfering with DDNC?

It may not be possible to successfully complete the apnea test for technical reasons, particularly due to the development of arrhythmia or hypotension prior to its completion. This mandates utilization of an ancillary test to fulfill DDNC.

Facial trauma, perforated tympanic membranes, or prior co-morbidities (e.g. chronic external ophthalmoplegia) may preclude successful completion of one or more components of the clinical examination. This mandates utilization of an ancillary test to fulfill DDNC.

Spontaneous body movements may occur which may be generated at the level of the spinal cord and do not, necessarily, invalidate the diagnosis of brain death.⁸ Such movements are usually slow and brief. These include attempts to flex the body at the waist, raise arms independently or together, or turn the head slowly to one side. Forceful flexion of the neck or rotation of the body may initiate some of these movements. The legs seldom move spontaneously.

Spinal reflex movements, i.e. limb or trunk movement in response to a stimulus delivered below the neck may occur and do not preclude DDNC. They include persistent Babinski signs, and tendon, abdominal and cremasteric reflexes.

What is the role of supportive, ancillary testing in the DDNC?

DDNC is predominantly a clinical diagnosis. Testing performed to validate DDNC is not mandatory if the etiology of DNC is apparent and sufficient in magnitude and duration for irreversibility to be ensured, and the clinical criteria outlined above including successful completion of the apnea test are unequivocally fulfilled.

Ancillary, supportive testing may be considered when there is contention on the part of the patient's family or the patient's health care team regarding the validity of the clinical diagnosis. Ancillary testing is mandatory if all aspects of the clinical determination of DNC including the apnea test cannot be completed, or if the etiology of DNC is not apparent.

What are the supportive, ancillary tests available for DDNC?

The selection of the specific ancillary, supportive testing is left to the discretion of the physicians caring for that patient.

1. Ancillary, supportive tests used to support the clinical diagnosis of brain death that have been generally accepted in the literature (listed with most sensitive test first).
 - A. Conventional angiography
 - B. Technetium-99 brain scan
 - C. EEG done under electrocerebral silence protocols
 - D. Transcranial doppler
2. The following tests have not been adequately demonstrated to be sufficiently sensitive and specific to be used as validation of DDNC.⁴
 - A. CT angiography
 - B. MR angiography
 - C. Somatosensory evoked potentials

Documentation of DNC

It is essential that the clinical criteria for the determination of death by neurological criteria including the apnea test as detailed in the policy, and if necessary ancillary testing, are adequately documented. This documentation should include both a progress note by the responsible neurologist, neurosurgeon, or critical care physician, as well as completion of the DDNC checklist (available in ECMS). The completed DDNC checklist is a part of the medical record and will be maintained in the chart and the electronic medical record.

1. The documentation of the neurological exam in the progress notes should be provided by the attending neurologist or neurosurgeon who performed or was responsible for the performance of this examination. If performed by a house officer or mid-level under direct attending staff observation and supervision, this note must be cosigned, dated and timed immediately by the responsible attending staff member. To ensure that no miscommunication transpires between different physicians involved in DDNC, the appropriate portion of the DDNC Checklist should be completed and maintained in the patient document portion of the chart.
2. The successful completion of the apnea test should be documented in the progress notes by either the attending neurologist, neurosurgeon, or intensivist who performed or was responsible for the performance of this examination. If performed or observed by a respiratory therapist or house officer, this note must be cosigned, dated and timed immediately by the responsible senior staff member. To ensure that no miscommunication transpires between different physicians involved in DDNC, the appropriate portion of the DDNC Checklist should be completed and maintained in the patient document portion of the chart.
3. Final documentation of DNC may be made by one of these attending physicians, or by any attending physician with meaningful involvement in the case, based upon the previously completed and documented neurological exam(s), apnea tests or supporting study(ies), when indicated. The appropriate portion of the DDNC Checklist should be completed and maintained in the patient document portion of the chart.

External influences on DDNC

DNC is a widely but not universally accepted concept both on moral, religious and legal grounds.⁹ In New York and New Jersey, statutory law allows for contestation of DDNC on a religious basis. Although Lahey Clinic recognizes and supports the sanctity and traditions of individual cultures and religions, it views DNC as a valid medical condition, determined by medically qualified personnel. As Lahey Clinic is sensitive to the aforementioned religious and cultural considerations, the Clinic will make every attempt to aid the family in fulfilling any cultural or religious requirements regarding burial in an expeditious manner, once death has been determined by any criteria.

Contact:
References:

Chair of Neurology
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