Determination of Death by Neurological Criteria (DNC)

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I. PURPOSE

This policy defines the criteria and procedure used to determine Death by Neurological Criteria for patients in IU Health inpatient facilities.

II. SCOPE

This policy applies to all IU Health care providers and medical team members within IU Health Hospitals.

III. EXCEPTIONS

This policy does not apply to patients less than 37 weeks adjusted gestational age.

IV. DEFINITIONS

Death by Neurological Criteria/Brain Death: Death by Neurological Criteria (DNC) and Brain Death are assumed to be equivalent and synonymous. DNC is defined as the permanent loss of all functions of the brain, including the brain stem. The three essential findings in DNC are coma, brainstem areflexia, and apnea. A patient determined to be brain dead is pronounced clinically and legally dead.

Pediatrics: Patients <18 years of age at the time of DNC.

Hypotension:

Pediatrics: Systolic blood pressure (SBP) OR mean arterial pressure (MAP) <5th percentile for age.

Adults: SBP < 100 mmHg OR MAP < 75 mmHg. For VA-ECMO patients only the MAP goals are applicable.

V. POLICY STATEMENTS

A. **Providers**

1. Eligible physicians to lead DNC testing include: Intensivist Physicians, Neurology Attending physicians, and Neurosurgery Attending physicians. Trainees and APPs may participate in exams with the direct supervision of an attending physician.
2. None of the providers involved in the DNC determination may be part of the organ transplant or procurement teams.

B. DNC is declared at the time of the final DNC examination (or time of attending read of ancillary study, if this is required due to clinical factors and is performed after the final examination).

C. **Documentation**

1. All phases of the determination of DNC should be documented in detail in the medical record, including etiology and permanence of coma, absence of brain stem reflexes, and apnea test results, as well as ancillary tests, if utilized, including justification for ancillary testing.
2. Documentation in the medical record may be completed by a trainee physician but must be cosigned by the attending physician who was supervising DNC testing.

D. Reasonable accommodations may be made for family preferences or needs (e.g., travel time) prior to the removal of medical therapies from the body after declaration of death by neurologic criteria. In most cases, removal of medical therapies should occur within 8 hours of the time of death. During this period of reasonable accommodation following the declaration of DNC, current medical treatment will be continued,

however, the medical team is not obligated to pursue new assessments or interventions.

E. Patient surrogate(s) should be notified of intent to perform DNC testing; however, consent is not required for clinical examinations, apnea testing, or ancillary testing necessary for the declaration of DNC nor can a patient's surrogate(s) refuse evaluation of DNC. Surrogate opposition to DNC examinations will not be honored, and communication with hospital leadership about such an attempted refusal is appropriate.

F. When conflict occurs between members of the medical care team and the patient's surrogate(s) regarding a patient who has been declared dead after DNC testing, members of the medical care team should notify hospital leadership as well as the Ethics Consultation Service. If there is consensus amongst the medical team, ethics, and hospital leadership about the appropriateness of the DNC declaration process and subsequent diagnosis, removal of medical therapies should generally occur within 8 hours. The dispute resolution process does not apply to deceased patients.

VI. PROCEDURES

A. Identify the proximate cause and permanence of the patient's coma:
   1. Patients must have clinical and neuroimaging evidence (whenever possible) of an acute central nervous system diagnosis compatible with the clinical diagnosis of DNC.
   2. Primary Posterior Fossa Injury: In patients with primary posterior fossa injury there should be neuroimaging evidence of supratentorial injury for DNC testing to be initiated.

B. Pre-requisites for DNC testing
   1. Observations periods:
      a. There must be an observation period between major clinical events that could lead to neurological injury and DNC.
         i. 24 hours for patients ≥ 2 years of age
         ii. 48 hours for patients < 2 years of age
      b. An observation period after any intervention performed with the intent to lower intracranial pressure should be observed.
         i. The duration of this observation period should be in line with the timeframe for a change in intracranial pressure based on physiological expectations of the intervention performed and the patient's underlying pathophysiology.

C. Rule out potentially reversible confounding factors:
   1. Exclude hypothermia: core temperature ≥36° C at the time of the exam. If core temperature falls to <35.5°C patient must be rewarmed to ≥36°C for 24 consecutive hours.
   2. Exclude hypotension (as defined above).
   3. Exclude the effect of sedative and neuromuscular blocking agents.
      a. Ensure that all CNS depressing medications have been discontinued.
      b. Ensure that at least five half-lives of any central nervous system depressing medication have passed before initiating testing (**see attached, List of half-lives and lab values**). Note that renal failure, hepatic dysfunction, and hypothermia may delay medication clearance. Note that in the context of toxic overdose, the five half-lives rule does not apply, In the event of a known or suspected overdose, discuss with Medical Toxicology via the Indiana Poison Center (1-800-222-1222) prior to brain death examination.
      c. If pentobarbital has been given, the level must be less than 5 µg/mL.
      d. Alcohol level, if tested, must be ≤ 80 mg/dL.
      e. If neuromuscular blocking medications have been given and it has been less than 5 half-lives, or if there is concern about delayed clearance, its effect can be assessed with deep tendon reflexes or train-of-four.
   4. Ensure that patient laboratory values that may affect DNC evaluation, if tested, are in a

physiologically acceptable range prior to DNC testing. ***See attached, List of half-lives and lab values.***

   a. If metabolic derangements are unable to be adequately corrected, with reasonable interventions, an ancillary test is needed to diagnose DNC.

5. If cervical spine injury is present or suspected and may confound full DNC evaluation, ancillary testing is indicated.

D. Number of exams
   1. Pediatrics: 2 exams, including apnea testing, performed by separate attending physicians are required separated by at least 12 hours, regardless of ancillary testing.
   2. Adults: There is a minimum of one exam, 2 exams can be done at the provider's discretion.

E. Contacts
   1. Notify the patient's surrogate decision-maker(s). Family members are encouraged to be present for bedside DNC evaluations if they want to be there.
   2. Notify Indiana Donor Network (1-800-356-7757).

F. Clinical assessment for DNC
   1. Assessment for coma
      a. No cerebral motor response to auditory, visual, or painful stimuli; with the exception of spinal-mediated reflexes.
      b. Ancillary testing indicates if it is unclear if limb movements are spinally mediated.
   2. Assessment of brainstem reflexes:
      a. Pupils: fixed and mid-position to dilated.
      b. Oculocephalic reflex (doll eye phenomenon) is absent.
         i. If oculocephalic reflex cannot be performed due to concerns for cervical spine injury, DNC can still be declared without ancillary testing, if all other components of the exam and apnea test are consistent with DNC.
      c. Oculovestibular reflex (cold caloric test) is absent (ensure 5 minutes between testing of each ear).
      d. Corneal reflex is absent.
      e. Cough and gag reflexes are absent in response to stimulation of the posterior pharynx and tracheal suctioning.
      f. Sucking and rooting reflexes are absent (applicable for patients < 6 months of age).
   3. Apnea testing
      a. No spontaneous respirations observed prior to initiation of testing.
      b. Physiologic prerequisites to apnea testing:
         i. Same pre-requisites as noted above for clinical exam.
         ii. Pre-oxygenation using 100% FiO2.
         iii. Baseline ABG should show pH 7.35-7.45 and PaCO2 35-45mmHg, if possible.
         iv. Chronic Hypercarbia: if baseline PaCO2 is known ABG should be corrected to that known baseline PaCO2 level to start. If baseline PaCO2 is not known, then starting PaCO2 should be estimated, and an ancillary test should be performed in addition to apnea test.
   4. Apnea test procedure
      a. Pulse oximeter and cardiac monitors in place, disconnect patient from mechanical ventilation.
      b. Connect oxygen source with 100% FiO2: flow inflating bag, CPAP on the ventilator, or catheter inside the endotracheal tube with 4-6L/min flow.
      c. Closely observe patient for spontaneous respiratory effort throughout test
      d. Obtain serial blood gases at brief intervals, at least every 8-10 minutes.
      e. Absence of respiratory effort with a PaCO2 ≥ 60 mmHg, an increase in PaCO2 of ≥20 mmHg, and pH<7.3 constitute an apnea test consistent with DNC.

5. Apnea testing should be aborted if:
    a. Persistent hypotension (as defined above) despite appropriate medical interventions.
    b. Persistent hypoxemia less than <85%. In chronically hypoxemic patients, a reduction in saturation by 15% from the patient's baseline saturation (not saturation after pre-oxygenation).
    c. Unstable arrhythmia.
6. If the patient does not tolerate apnea testing, interventions can be made such as pre-apnea test ventilator changes or changes to vasoactive infusions, and the apnea test can be attempted again.
7. An ancillary test is required to make the diagnosis of DNC if the apnea test cannot be completed.

G. ECMO Considerations for Apnea Testing.
1. Only MAP goal, as noted above, is necessary to adequately exclude hypotension.
2. Pre-oxygenate with 100% FiO_2 via ventilator and membrane lung
3. In addition to removing the ventilator from the endotracheal tube, titrate down sweep to allow CO_2 to accumulate. Introduction of exogenous CO_2 may be done if the membrane lung sweep cannot be lowered enough for CO_2 to accumulate.
4. For patients on VA ECMO, pH, and CO_2 on ABGs from both post membrane and the patient must meet criteria for apnea test to be consistent with DNC. Patients on VV ECMO only need ABGs from the patient arterial line to meet criteria.

H. Ancillary testing
1. Ancillary testing is utilized in the following circumstances:
    a. The neurological examination or apnea test cannot be completed due to clinical factors, with the exception of the oculocephalic reflex as noted above. (e.g., cervical spinal cord injury, hypoxia, hemodynamic instability, etc.)
    b. Uncertainty among clinicians regarding clinical exam findings that may be spinal reflexes.
    c. Concern for confounding factor of exam that cannot otherwise reasonably be resolved.
    d. Chronic hypercarbia with unknown baseline PaCO2.
2. Ancillary testing should NOT be done:
    a. To shorten observation periods or inter-exam time for pediatric patients
    b. Due to confounding factors that can be reasonably corrected
    c. To avoid portions of the exam that can feasibly be tested
    d. To avoid waiting for drug clearance
3. Ancillary testing, if indicated, should be done after the final exam and apnea test is completed and all components performed are consistent with a diagnosis of DNC.
    a. Acceptable ancillary tests:
        i. Cerebral perfusion studies
            - A cerebral radionuclide perfusion study that demonstrates an absence of intracerebral blood flow is consistent with the diagnosis of DNC.
        ii. 4-vessel catheter angiography
            - Shows lack of perfusion to both the anterior and posterior circulations is consistent with DNC.
        iii. Transcranial Doppler:
            - Detecting oscillating flow or systolic spikes in proximal large intracranial arteries is consistent with DNC. ONLY FOR USE IN ADULTS.

I. Pregnancy Considerations
1. Termination of medical therapies is not required for a pregnant patient post declaration of DNC if, in the opinions of the attending physician and obstetrical specialist, there is a reasonable possibility that the fetus could develop to the point of live birth with the use of physiological support systems, and this approach is consistent with the values and preferences of the patient (if known) and the patient's surrogate decision-maker (s). This issue should be referred to the Ethic Consultation Service assigned

to the facility and the facility Risk Director, and the physician shall consult with such personnel before making a DNC determination.

2. If the team determines that pursuit of continued medical therapies toward a live birth is medically inappropriate and/or unreasonable, they are not obligated to continue said therapies.

VII. CROSS REFERENCES

None

VIII. REFERENCES/CITATIONS

Greer, David M., et al. "Pediatric and Adult Brain Death/Death by Neurologic Criteria Consensus Guideline: Report of the AAN Guidelines Subcommittee, AAP, CNS, and SCCM." *Neurology*, 11 Oct. 2023, n.neurology.org/content/early/2023/09/13/WNL.0000000000207740, https://doi.org/10.1212/WNL.0000000000207740.

- Pediatric and Adult Brain Death/Death by Neurologic Criteria Consensus Guideline | Neurology

IX. FORMS/APPENDICES

List of half-lives and lab values

Optional BD/DNC Exam Checklist

X. APPROVAL BODY, IF APPLICABLE

Medical Staff Executive Committee

Board of Directors