UAB MEDICINE **Interdisciplinary Policy**

Title:	*Brain Death, Guidelines for Determination of*				
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Endorsed:	N/A Date	Endorsed:	*James Hunter* 9/18/24 James Hunter, MD Date Chair Patient Rights & Ethics Committee	Page 1 of 6 Written 03/31/94 Reviewed 03/14/24 Revised 08/19/24 Issued 09/17/24	
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PURPOSE: To establish guidelines for the determination of brain death in patients with catastrophic brain injury.

SCOPE: This policy applies to all adult patients and children at least 37 weeks of age.

DEFINITIONS:

A. *Brain Death(BD), or Death by Neurologic Criteria (DNC):* Clinical diagnosis of the complete and irreversible cessation of all functions of the entire brain, including the brain stem.
B. *Pupillary reflexes:* Pupils constrict to direct light.
C. *Corneal reflexes:* There is a blink response (which may be partial) to corneal stimulation.
D. *Oculocephalic reflex:* Eyes rotate to the opposite side of the direction of head rotation.
E. *Oculovestibular reflex:* There is deviation of the eyes during or following the slow injection of at least 50-60 mL of ice water into the external acoustic meatus, with the head of bed at 30 degrees.
F. *Oropharyngeal or tracheal reflex:* Pharyngeal or tracheal stimulation elicits cough or gag.
G. *Spontaneous respiration:* Abdominal or chest excursions that produce any measurable tidal volume.

BACKGROUND: This document represents an update of the UAB Brain Death Guidelines document, last published in 2018. These guidelines incorporate the 2023 American Academy of Neurology Pediatric and Adult Brain Death/Death by Neurologic Criteria Consensus Guidelines and the current Alabama statute regarding diagnosis of brain death.

PURPOSE AND APPROPRIATE USE OF BRAIN DEATH DETERMINATION: The determination of brain death in a patient following a catastrophic brain injury is a legal declaration of death by neurological criteria. This is a permanent state with no prospect for recovery of neurological function. Brain death determination is necessary for specific clinical situations, most often organ donation. Brain death determination is also appropriate when the patient's family or legally authorized representatives request or require a clear demonstration of irreversible profound brain injury, and in other situations where the family or legally authorized representatives cannot be reached. Importantly, determination and documentation of brain death is *not* necessary for compassionate withholding or withdrawal of life-sustaining therapy in patients with catastrophic brain injury and no expectation of a meaningful recovery.

POLICY:

A. The proximate cause of catastrophic brain injury must be established and documented, based on history, imaging, and neurological examination.
    a. In cases in which the cause of an unresponsive state is unclear, then brain death determination shall be postponed until a cause is identified.
B. Consent is not necessary for brain death determination.
C. Prior to brain death determination, all potential confounding factors shall be assessed for, ruled out, and documented.
    a. Potential confounding factors include intoxication, central nervous system depressant medications, hypothermia, hypotension, and paralytic agents.
    b. Core temperature should be ≥36.0°Celsius and MAP should be ≥75mmHg.
D. Brain death determination is based on clinical grounds and neurological examination.
E. Two physicians must complete and document the brain death examination independently. House officers at the level of post-graduate year two or higher may perform brain death examinations with faculty supervision or oversight. There is no specific time interval that must occur between the two brain death examinations. In adults, only one examination must include testing for spontaneous respiration. Physicians involved in brain death evaluation shall not be associated with the transplant team or with the care of any potential recipient.
F. Primary criteria to establish brain death must include all of the following:
    a. Absence of cerebral function.
    b. Absence of brainstem function, including spontaneous respiration.
    c. Irreversibility of the condition.
G. <u>Absence of cerebral function</u>
    a. Cerebral function is absent when no movement is observed, and no response is detected in response to centrally-applied deep pain stimulation.
    b. Spinal cord-mediated reflexive responses, such as those seen with noxious stimulation applied to the extremities, may be observed in patients with brain death.
H. <u>Absence of brainstem function</u>
    a. Brain stem function is absent when none of the following cephalic reflexes occur and cannot be elicited by stimulation of any part of the body, and no respiratory movements occur either while on the ventilator or during the apnea test (see below).
        i. Absent pupillary reflexes.
        ii. Absent corneal reflexes.
        iii. Absent oculocephalic reflex.
        iv. Absent oculovestibular reflex.
        v. Absent oropharyngeal or tracheal reflex.
        vi. Absence of spontaneous respiration.
I. <u>Apnea Test</u>
    a. The apnea test should be reserved as a final diagnostic verification and only used when the diagnosis of brain death is reasonably certain and after all other cerebral and brain stem responses have irreversibly disappeared.
        i. Prior to initiating the apnea test, the clinician should ensure that the patient is not hypotensive, hypovolemic, or hypoxic.
        ii. The patient's body temperature should be maintained ≥36.0°C during the evaluation.

b. The apnea test should be preceded by ventilating the patient for at least 10 minutes with 100% oxygen to minimize hypoxemia during the test period. A baseline arterial blood gas is obtained following this period of hyperoxygenation.
    i. Ideally, the baseline PaO_2 should be >200 mmHg, to minimize the risk of developing clinically significant hypoxia during testing.
    ii. The pH should be normal (7.35-7.45) prior to initiating the apnea test. For patients without a baseline history of CO_2 retention, the $PaCO_2$ should be normal (35-45 mmHg). For those with a known history of CO_2 retention, the $PaCO_2$ level prior to testing should be at the patient's premorbid baseline, if this is known.
c. The patient is then removed from the ventilator. Supplementary oxygen should be provided.
    i. Typically, supplemental oxygen is administered using a narrow bore cannula positioned in the endotracheal tube with O_2 flowing at a rate of 6 L/min, but this method may not be suitable for hypoxemic patients or those with endotracheal tubes smaller than 7.0.
    ii. Alternative means of apneic oxygenation include:
        a) Delivering 100% oxygen through CPAP on the ventilator.
        b) Disconnecting the ventilator from the patient's ETT/tracheostomy and delivering 100% oxygen through a flow-inflating resuscitation bag with a functioning PEEP valve.
d. During the apnea test, adequate blood pressure and oxygenation must be maintained. The patient should be observed closely for evidence of respiratory effort.
e. The apnea test should be aborted prematurely if:
    i. Respiratory effort is noted;
    ii. O_2 saturation drops below 85% on pulse oximetry;
    iii. SBP <100 and/or or MAP <75 despite fluids and/or vasopressors,
        a) this threshold applies to adult patients who are not requiring mechanical circulatory support; see section on Special Considerations for criteria applicable to pediatric and ECMO patients; or
    iv. significant cardiac dysrhythmias occur.
f. Serial ABGs:
    i. If point of care blood gas testing is available, and arterial access is present, perform serial ABGs (approximately every 2 minutes) beginning at approximately 8 minutes of apnea, if the patient does not have hemodynamic instability or hypoxemia, until the ABG results are consistent with the criteria below.
    ii. If point of care blood testing is not available, or if arterial access cannot be obtained, send an ABG after approximately 8 minutes of apnea, but continue apnea testing/repeat the ABG every 2-3 minutes if the patient is hemodynamically stable until the ABG results are consistent with the criteria below. The duration of testing is typically 10-15 minutes but can be carried out for longer if the patient is stable.

g. Criteria for apnea test consistent with brain death must include:
    i. A $PaCO_2$ of ≥60 mmHg and ≥20 mmHg from baseline,
    ii. pH <7.3, and
    iii. The absence of respiratory effort.
    iv. If the apnea test must be aborted prematurely, a blood gas should be obtained at the time of resumed mechanical ventilation.
        a) If the requirements set forth above are met the test may be considered positive and supportive of a brain death diagnosis.
        b) Otherwise, the test is indeterminate and may suggest the need for ancillary testing or a repeat apnea test with improved hemodynamic support and/or alternative method of passive oxygenation.
        c) In patients with baseline hypercapnia in whom the baseline $PaCO_2$ is unknown, an ancillary test should be considered.

J. Ancillary tests
    a. Ancillary testing should only be used in situations in which a portion of the neurological examination cannot be completed, an apnea test cannot be successfully completed, or when the findings of the examination cannot be interpreted adequately. These circumstances include:
        i. Injuries to the head or spine that impede brainstem reflex assessment.
        ii. Patients who are too medically unstable to tolerate an apnea test.
        iii. Neurological findings that are difficult to interpret.
        iv. Metabolic derangements that cannot be reversed.
    b. Ancillary tests are used to confirm absence of brain perfusion. Electroencephalography, auditory evoked potentials, and somatosensory evoked potentials do not adequately assess brainstem function and shall not be used as an ancillary test. Brain perfusion tests that may be used include:
        i. Radionuclide perfusion scintigraphy.
        ii. Transcranial Doppler ultrasonography (in adult patients).
        iii. Four-vessel cerebral angiography.
    c. Note: CT and MR angiography have not been validated in the determination of brain death and should not be used as ancillary tests in this setting.

K. Medical Record Documentation
    a. The UAB Brain Death Note template should be used to document the brain death exams.
    b. The time of death is designated as the time of the final ABG demonstrating $PaCO_2$ and pH levels consistent with brain death, unless an ancillary test is required.
    c. For patients in whom an ancillary test is required, the time of death is listed as the time when the attending clinician report of the study results is finalized.

L. Management after Brain Death Determination
    a. After brain death determination, if organ donation is not anticipated (by Legacy of Hope or if the deceased's family declines), then life-sustaining therapies must be withdrawn within 3 hours. This interval may be extended at the discretion of the attending physician for specific situations, such as when family members are enroute and are expected within hours, and when clergy is enroute to perform post-mortem rituals.

SPECIAL CONSIDERATIONS:

A. Pediatric Patients
   a. BD/DNC cannot be declared in infants younger than 37 weeks corrected gestational age.
   b. For individuals ≥37 weeks corrected gestational age and <24 months old, clinicians should wait a minimum of 48 hours following brain injury prior to beginning the brain death evaluation.
   c. A minimum interval of 12 hours should separate the 2 clinical examinations in children (defined as those ≥37 weeks corrected gestational age and <18 years of age). Both examinations in pediatric patients must include an apnea test.
   d. When performing an apnea test in children, clinicians should maintain SBP and MAP ≥ the fifth percentile for the patient's age. For children being supported via venovenous (VV) ECMO, the MAP criteria alone may be used.
   e. In infants <6 months of age, the clinician should evaluate the sucking and rooting reflex as part of the clinical assessment. Absence of these reflexes is consistent with the diagnosis of brain death.
   f. Transcranial Doppler is not recommended as an ancillary test in the pediatric population. SPECT radionucleotide perfusion studies and cerebral angiography are the recommended alternatives.

B. Hypoxic Ischemic Brain Injury
   a. In patients aged ≥24 months with brain injury due to cardiac arrest, brain death evaluation should be deferred for a minimum of 24 hours after successful return of spontaneous circulation.
   b. In patients treated with therapeutic hypothermia, brain death evaluation should be deferred until the patient has been normothermic (≥36.0^{0}C) for at least 24 hours.

C. ECMO Patients
   a. Brain death can be diagnosed in patients undergoing ECMO support, assuming confounders such as drug effect and metabolic derangements can be adequately excluded.
   b. In order to perform an apnea test in this population,
      i. Preoxygenate using 100% FiO_2 on the ventilator and the membrane lung.
      ii. Decrease the sweep gas flow rate to 0.2-1 L/min to permit CO_2 levels to rise. Alternatively, exogenous CO_2 can be titrated into the ECMO circuit.
      iii. For patients on venoarterial ECMO, ABGs must be obtained from both the ECMO circuit and a distal arterial line.
         1. For patients cannulated via the right carotid or axillary artery, the distal arterial sample may be drawn from the left upper extremity or either lower extremity.
         2. In patients who are cannulated femorally, the right upper extremity should be used.
      iv. Both arterial blood gases must meet the criteria outlined in Section I in order to confirm the diagnosis of brain death.

D. Primary Posterior Fossa Injury
   a. In patients with primary posterior fossa injury, clinicians should ensure that there is also neuroimaging evidence of associated supratentorial pathology prior to evaluating for brain death.
   b. This precaution is intended to ensure that brain death is not erroneously diagnosed in a patient with residual cerebrocortical function (i.e., "locked in syndrome").

E. Pregnant Patients
   a. Pregnant patients may undergo declaration of brain death. For these patients, it may be feasible to maintain organ support for the purpose of supporting a viable infant.
   b. Decisions about continuation or discontinuation of organ support should be based on the viability of the fetus.
   c. After determination of brain death in a pregnant patient, the benefits and risks of continuing organ support should be discussed with the patient's legally recognized surrogate decision maker(s), and, if applicable, the fetus's legally-recognized surrogate decision makers along with the assistance of clinicians with expertise in pertinent fields, to include maternal-fetal medicine, neonatology, and pediatric neurology, and others as needed.

CONTENT BELOW THIS LINE IS ADMINISTRATIVE AND IS NOT PART OF THIS POLICY.

...**REFERENCES:**

1. Greer DM, Kirschen MP, Lewis A, Gronseth GS, Rae-Grant A, Ashwal S, et al. Pediatric and adult brain death/death by neurologic criteria consensus guideline. *Neurology*. 2023;101:1112-1132
2. Alabama code title 22. Health, mental health, and environmental control § 22-31-1. 2022

CMS:		**TJCH:**	
NFPA Ref #			

Cross-References (CR):

Death Care	*Advance Directives for Health Care*	*Organ Donation*

ATTACHMENTS: None

INTERDISCIPLINARY COLLABORATION

None

Physician / Medical Committees	**Endorsement Date**
None	
Committees / Councils	Endorsement Date
Robert Johnson, Senior Director, Respiratory Services	*5/24/24*
Megan Crumpton, Manager, Respiratory Services	*5/24/24*
Department(s)	Endorsement Date

Tracking Record

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REVISIONS: Consistent with Joint Commission Standards, this policy is to be reviewed at least every 3 years and/or as practice changes.	