Scope: All attending physicians certified to determine brain death.

Statutory Background

Uniform Determination of Death Act
(Adopted in various forms in most states including Connecticut)

"An individual who has sustained either (1) irreversible cessation of circulatory and respiratory functions, or (2) irreversible cessation of all functions of the entire brain, including the brain stem is dead. A determination of death must be made in accordance with accepted medial standards."

Connecticut Determination of Death Statutes Section 19a-504a (b) (Continuation or removal of life support system. Determination of death.)

"For purposes of making a determination concerning the continuation or removal of any life support system in a general hospital licensed under section 19a-491, an individual who has sustained either (1) irreversible cessation of circulatory and respiratory functions, or (2) irreversible cessation of all functions of the entire brain, including the brain stem, is dead. A determination of death must be made in accordance with accepted medical standards."

Section 19a-289m (i) (Rights and responsibilities of a procurement organization. Donee's rights. Procedures for removing or transplanting donated body parts)

"Neither the physician who attends the decedent at death nor the physician who determines the time of the decedent's death may participate in the procedures for removing or transplanting a part from the decedent."

Standard for Determination of Death

For the purpose of these criteria, an individual is dead after a defined, irreversible brain insult results in cessation of all brain function, including the brain stem.

Definitions: For the purposes of this policy, an "attending physician certified to determine brain death" as required by the Medical Staff shall be defined as a Board Eligible/Certified Neurologist, Intensivist, Anesthesiologist, Surgeon or Neurosurgeon on the Medical Staff certified as qualified for these determinations by their departments/divisions. Residents/Fellows in the above disciplines, certified as qualified for brain death determinations by their departments/divisions may also participate as defined below.

For the purposes of this policy, "adult" is defined as all patients aged 18 years and older.

For the purposes of this policy, the "functions of the entire brain" that are relevant to the determination of death are those that are clinically ascertainable. Confirmation by laboratory tests described herein is performed at the discretion of the clinician and is not required.

Policy:

A. General Determination of death hereunder requires a written documentation of the findings of one examination by at least two physicians qualified for brain death determinations (one of whom must be an attending physician and one who may be a resident/fellow) with documentation of the appropriate supporting medical data in the patient's chart. The Brain Death Progress Note form (#571120) shall be completed for documentation of the examination and placed in the chart. In the event death is being determined for purposes of anatomical donations, physicians participating in the removal or transplant procedure must exempt themselves from death determination in these instances.

B. Timing of Examination An observation period of at least three hours is required prior to initiating the formal examination for the determination of brain death. Because cardiovascular instability often occurs following brain death, formal examination should begin as soon as possible after the three hour observation period has passed. The observation period may be decreased to a minimum of one hour if, in the opinion of the physicians performing the formal examination for the determination of brain death, the cause of the patient's brain injury is non-survivable and/or neuroimaging is consistent with brain death. This observation period will begin after documentation in the medical record of a neurologic examination performed by an MD, RN and/or Advanced Practitioner revealing the absence of cortical and brain stem function.

The examination must include the following:

- Absence of motor responsiveness to painful stimuli
- Spinally mediated motor responsiveness does not represent the presence of cortical or brain stem function
- Absence of bilateral pupillary light reflex;
- Absence of bilateral corneal reflex;
- Absence of bulbar reflex (cough and gag reflexes);
- Absence of spontaneous breaths

C. Confirmatory Testing Confirmatory tests (see E. 3.) are not required unless any of the following conditions apply or other anatomic abnormalities exist, which preclude a complete evaluation.

The following conditions may interfere with the clinical diagnosis of brain death:

- Severe cardio or respiratory instability;
- Severe facial trauma;
- Pre-existing pupillary abnormalities;
- Supratherapeutic dosages of any sedative drugs, or drugs with CNS effects or ability to affect respiratory drive or function such as aminoglycosides, tricyclic antidepressants, anticholinergics, antiepileptic drugs, chemotherapeutic agents, or neuromuscular blocking agents (see Complicating Conditions A);
- Sleep apnea or severe pulmonary disease resulting in chronic retention of CO_2;
- Less than 24-hours from a hypoxic/anoxic event causing suspected neurologic condition

D. Documentation The standardized Brain Death Progress Note form shall be completed and placed in the medical record to document the performance and results of the examination. The forms are available in each Intensive Care Unit. A sample of this form is provided in the Appendix.

E. Examination for the Determination of Death by Brain Death Criteria The following criteria must be met:

1. CESSATION OF ALL FUNCTIONS OF THE ENTIRE BRAIN WHEN THE CAUSE OF THE INSULT IS KNOWN AND IS IRREVERSIBLE. THE EVALUATION MUST DEMONSTRATE FINDINGS OF 1a **AND** 1b:

a. CEREBRAL FUNCTIONS ARE ABSENT: There is cerebral unreceptivity and unresponsiveness as evidenced by total unresponsiveness to environmental stimuli. There will be no spontaneous movement and no cerebral motor response to noxious stimuli applied to the supraorbital ridge and nail beds of all four extremities.

Purely spinal reflexes, such as the deep tendon reflexes and the triple flexion response may be maintained. Decorticate or decerebrate posturing, indicative of diencephalic and/or brain stem function exclude the patient from a declaration of brain death. The following clinical observations are compatible with the diagnosis of brain death and should not be misinterpreted as evidence for brain stem function:

- Spontaneous movements of limbs due to spinal reflexes
- Respiratory-like movements (shoulder elevation and adduction, back arching, intercostals expansion without significant tidal volumes);
- Sweating, blushing, tachycardia
- Normal blood pressure without pharmacologic support or sudden increases in blood pressure
- Absence of diabetes insipidus
- Deep tendon reflexes; superficial abdominal reflexes; triple flexion response
- Babinski reflex

b. BRAIN STEM FUNCTIONS ARE ABSENT: Pupillary light, corneal, oculocephalic, oculovestibular, oropharyngeal and respiratory (apnea) reflexes should be tested. When any one of these reflexes (excluding oculocephalic) cannot be adequately assessed, because of anatomical deformity or cardio/respiratory instability, a confirmatory test is required. The reason for the inability to perform any portion of the exam must be documented on the progress note form.

i) Pupils The pupils will be fixed and greater than or equal to 4mm in diameter and will not respond to sharp changes of light intensity. A magnifying glass may be useful if response is uncertain. Both direct and consensual pupillary response will be absent. Mydriatic agents can confound the pupillary exam. If there is a possibility of pupillary effect by prior mydriatic agent administration, then a confirmatory test must be obtained.

ii) Corneal Reflex The corneal reflexes will be absent. The eyes will be checked for both direct and consensual blink responses. An effort will be made to ascertain the patient's status as either a contact wearer or the recipient of previous eye surgery, which might blunt the response to the corneal reflex test. If known or suspected corneal abnormalities would preclude proper exam, then the criteria for confirmatory testing would apply.

iii) Oropharyngeal (Bulbar) Reflex No cough, gag or response to endotracheal suctioning will be present.

iv) Oculocephalic Reflex The response to the oculocephalic (doll's eyes) maneuver is absent. This test will be done only after suitable x-ray examination of the cervical spine in the injured patient indicates no apparent fracture(s) or instability. The test is performed by observing the eyes while quickly turning the head to both sides. The absence of the oculocephalic reflex will be indicated by the eyes remaining in a fixed position with head movement.

v) Oculovestibular Reflex Oculovestibular (caloric) response will not be present. The procedure will be to place the patient's head of bed at 30 degrees and to instill 50cc ice water in the ear after otoscopic inspection has insured that the external auditory canal is patent, that the stimulus can reach the tympanum, and that the tympanum is intact. The test will be performed on both sides with the lapse of at least 5 minutes between the deliveries of stimuli. Conjugate eye deviation towards the stimulus during at least a minute of observation should not be present.

vi) Apnea Test Spontaneous respiration will be absent. The procedure for documenting apnea in the patient will be performed by the physicians and Respiratory Care Practitioner as follows:

Patient's body temperature should be greater than or equal to
36.5^{o}C (97^{o}F) and serum potassium within normal limits.

Draw an arterial blood sample to ensure that P_aCO_2 is between 32-50mmHg and that the pH is between 7.35-7.45. If the blood gas shows that these values are not within these ranges, make necessary ventilator adjustments and/or administer $NaHCO_3$ and repeat arterial blood gas sample. The Respiratory Care Practitioner will set up the equipment and calculate the goal $EtCO_2$ per the Apnea Test Procedure outlined in the Respiratory Care Department Procedure Manual.

When the above conditions have been met, begin the flow of Carbogen (3% CO_2 and 97% O_2), adjust the ventilator to SIMV mode with a rate of 4 breaths per minute, the sensitivity on the ventilator to Psens of 2 or greater and a pressure support of 5 cmH_2O or greater to aid in the detection of spontaneous respiratory efforts. Monitor the increase in $EtCO_2$ while observing the patient and ventilator screen for spontaneous respiratory efforts. The IMV rate may be decreased gradually by 1 breath/minute if the $EtCO_2$ has not increased incrementally or is not likely to reach the calculated $EtCO_2$ goal within 10 minutes. Draw an arterial blood sample when the calculated target $EtCO_2$ is reached. Return the patient to previous ventilator settings and discontinue the flow of Carbogen.

The Apnea Test is terminated:

1. When the $EtCO_2$ goal is reached and the arterial blood gas is drawn;
2. If there is a significant change in heart rate, blood pressure, cardiac rhythm or O_2 saturation, indicating an unstable or critical situation. An arterial blood gas should be drawn prior to returning the patient to the previous ventilator settings.

Confirmation of Apnea: If the pCO_2 is greater than or equal to 60mmHg **or** there is an increase of 20mmHg or greater in the normal baseline pCO_2 **and** there were no spontaneous respiratory efforts detected by the observers or mechanical ventilator, apnea is confirmed.

2. IRREVERSIBILITY IS RECOGNIZED WHEN EVALUATION DISCLOSES FINDINGS OF 2a **AND** 2b **AND** 2c:

A. THE CAUSE OF COMA IS ESTABLISHED AND IS SUFFICIENT TO ACCOUNT FOR THE LOSS OF BRAIN FUNCTIONS AND... Most difficulties with the determination of death on the basis of neurologic criteria have resulted from inadequate attention to this basic diagnostic prerequisite. In addition to a careful clinical examination and investigation of history, relevant knowledge of causation may be acquired by computed tomographic scan, measurement of core temperature, drug screening, EEG, angiography, or other procedures.

B. THE POSSIBILITY OF RECOVERY OF ANY BRAIN FUNCTIONS IS EXCLUDED, AND... The most important reversible conditions are sedation, hypothermia, neuromuscular blockade and shock (vide infra). A determination that blood flow to the brain is absent can be used to demonstrate a sufficient and irreversible condition.

C. THE CESSATION OF BRAIN FUNCTIONS PERSISTS FOR A MINIMUM OF 1 TO 3 HOURS OF OBSERVATION WITH OR WITHOUT A TRIAL OF THERAPY.

Even when coma is known to have started at an earlier time, the absence of brain functions must be established at the initiation of the observation period (See B: Timing of Examination)

3. Confirmatory tests include (in decreasing order of sensitivity): cerebral angiogram, electroencephalography, transcranial Doppler ultrasonography (TCD) and radionuclide brain flow study.

Tests of Blood Flow Complete cessation of circulation to the normothermic adult brain for more than 10 minutes is incompatible with survival of brain tissue. Documentation of this circulatory failure is therefore evidence of death of the entire brain. Four-vessel intracranial angiography is confirmatory for diagnosing cessation of circulation to the entire brain (both cerebrum and posterior fossa) but entails substantial practical difficulties and risks. Tests are available that assess circulation only in the cerebral hemispheres, namely radioisotope cerebral angiography. Without complicating conditions, absent cerebral blood flow as measured by these tests, in conjunction with the clinical determination of cessation of all brain function is diagnostic of death.

For TCD's, one of two patterns must be observed: a) absence of diastolic flows or reverberating flow indicating high vascular resistance associated with greatly increased intracranial pressure; b) small systolic peaks in early systole. Lack of TCD signal cannot be interpreted as confirmatory of brain death as 10% of patient may not have temporal insonation windows.

Test of Electrical Activity Electrocerebral silence verified irreversible loss of cortical functions, except in patients with drug intoxication or hypothermia. (Important technical details are provided in, American Electroencephalographic Society, Guidelines in EEG 1980, section 4: "Minimum Technical Standards for EEG Recording in Suspected Cerebral Death," pp.19-24, Atlanta, 1980). When joined with the clinical findings of absent brain stem functions, electrocerebral silence confirms the diagnosis.

The absence of evoked potentials is not a criterion of brain death. The examiner may elect to use short latency evoked potentials to ascertain that brain activity is present.

4. Complicating Conditions

Drug and Metabolic Intoxication Drug intoxication is the most serious problem in the determination of death, especially when multiple drugs are used. Cessation of brain functions caused by sedative and anesthetic drugs, such as barbiturates, benzodiazepines, meprobamate, methaqualone, and trichloroethylene, may be completely reversible even though they produce clinical cessation of brain functions and electrocerebral silence. The presence of a supratherapeutic CNS-depressant drug effect should be excluded by history, drug screen, calculation of clearance using 5 times the drug's half-life (assuming normal hepatic and renal function), or, if available, drug plasma levels within or below the therapeutic range. If the particular drug is not known but high suspicion persists, the patient should be observed for 48-hours to determine whether a change in brain stem reflexes occurs;

if no change is observed, a confirmatory test should be performed. A period of observation Longer than 48-hours may be necessary if renal or hepatic function is severely impaired. Prior use of hypothermia may also delay drug metabolism. The legal alcohol limit for driving (blood alcohol content 0.08%) is a practical threshold below which an examination to determine brain death could reasonably proceed. Toxicology consult service is available if there are questions regarding intoxicants.

Total paralysis may cause unresponsiveness, areflexia, and apnea that closely simulate death. Exposure to drugs such as neuromuscular blocking agents or aminoglycoside antibiotics, and diseases like myasthenia gravis are usually apparent by careful review of the history. Prolonged paralysis after use of succinylcholine chloride and related drugs requires evaluation for pseudocolinesterase deficiency. If there is any question, low-dose atropine stimulation, electromyogram, peripheral nerve stimulation, EEG, tests of intracranial circulation, or extended observation, as indicated, will make the diagnosis clear.

In drug-induced coma, EEG activity may return or persist while the patient remains unresponsive, and therefore the EEG may be an important evaluation along with extended observation.

If barbiturates are used to control intracranial pressure, and, in the event that the barbiturate level can be documented to be less than or equal to 10mg/mL, the above guidelines may be used to establish brain death on a clinical basis. Barbiturate level of greater than 10mg/L (10mcg/mL) precludes the declaration of brain death.

Some severe illnesses (e.g. hepatic encephalopathy, hyperosmolar coma, and pre-terminal uremia) can cause deep coma. Before irreversible cessation of brain functions can be determined, clinically relevant severe metabolic abnormalities (serum chemistry, acid-base, endocrine) should be considered and, if possible, corrected. Confirmatory tests or circulation or EEG may be necessary.

Hypothermia

Criteria for reliable recognition of death are not available in the presence of hypothermia (below 32oC core temperature [90oF]). However, minimal body temperature required for the apnea test procedure is 36.5oC (97oF). The patient may need to be warmed to achieve this temperature in order to perform the apnea test. The variables of cerebral circulation in hypothermic patients are not sufficiently well studied to know whether tests of absent or diminished circulation are confirmatory.

Hypothermia can mimic brain death by ordinary clinical criteria and can protect against neurologic damage due to hypoxia.

Further complications arise since hypothermia also usually precedes and follows death. If these complicating factors make it unclear whether an individual is alive, the only available measure to resolve this issue is to restore normothermia. Hypothermia is not a common cause of difficulty in the determination of death.

Shock

Physician should also be particularly cautious in applying neurologic criteria to determine death in patients in shock because the reduction in cerebral circulation can render clinical examination and laboratory tests unreliable. The systolic blood pressure shall be 100mmHg or greater or the mean arterial blood pressure shall be 60mmHg or greater; pressure less than this level shall be indicative of shock and should be treated prior to initiating testing for brain death.

Key Words Search: Brain Death, Apnea Test

Reference: Wijdicks FM 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.

BRAIN DEATH PROGRESS NOTE

The basic requirement for the declaration of brain death is the irreversible loss of cortical and brain stem activity in the adult. This requirement has three facets: absent brain stem reflexes, absent cortical activity, and a demonstration that this state is irreversible. One clinical exam must be performed by two physicians certified to determine brain death after an observation period of at least 3 hours. The examination must include testing for apnea. Contact LifeChoice Donor Services (1-800-874-5215) prior to initiating brain death examination. The details of this protocol are explained in the Policy for Determination of Death by Brain Death Criteria. This form must be completed and placed into the medical record.

PREREQUISITES FOR THE CLINICAL DETERMINATION OF BRAIN DEATH:

1. Etiology of irreversible coma is known: ☐ yes ☐ no Cause: _____
2. Neuroimaging compatible with brain death: ☐ yes ☐ no Results: _____
3. Supratherapeutic drug effect ruled out (see policy): ☐ yes ☐ no Drug Level: _____
4. Clinically relevant, severe serum chemistry, acid-base and endocrine abnormalities adequately treated: ☐ yes ☐ no ☐ n/a
(explain):_____
5. Core temperature ≥ 36.5°C (97°F) ☐ yes ☐ no

	Examination	Comments
Time:	am / pm	
Date:		
Blood Pressure:		
Cortical Function:		
Body Temp:		
Responsiveness to stimuli:		
Supraorbital Ridge Pressure	❒ Present ❒ Absent	
Nail Bed Pressure	❒ Present ❒ Absent	
Brain Stem Function:		
Pupil Size	Right _____mm Left _____mm	
Pupillary light reflex:	❒ Present ❒ Absent	
Corneal reflex:	❒ Present ❒ Absent	
Oculocephalic reflex:	❒ Present ❒ Absent	
Oculovestibular reflex:	❒ Present ❒ Absent	
Bulbar reflex: (gag/cough):	❒ Present (gag) ❒ Absent (gag) ❒ Present (cough) ❒ Absent (cough)	

6. Systolic BP > 100 mmHg or Mean Arterial Pressure >60mmHg ☐ yes ☐ no

Any "no" response above, requires a confirmatory test be obtained after the clinical exam and apnea test.

CLINICAL EXAM:

APNEA TEST: Start time:_____ End time:_____ Duration of test: _____ minutes

❒ **There were no spontaneous respirations observed.**

Initial Arterial pH:	Initial P_aCO_2:	Final Arterial pH:	Final P_aCO_2:
( )	( ) torr	( )	( ) torr

CONFIRMATORY TESTS (if performed):

❒ EEG ❒ Radionuclide Scan ❒ Cerebral Angiography ❒ TCD (performed by: _____)

Date:_____Time:_____am/pm Results:_____

We have performed this examination according to the procedure outlined in the Policy for Determination of Death by Brain Death Criteria and we concur that this patient has met the criteria for brain death.

Time of Death: _____

(Time apnea test completed or time confirmatory test read)

_____, MD/DO _____ _____

Physician's Signature (#1) Date Time

_____, MD/DO _____ _____

Physician's Signature (#2) Date Time