

Purpose

This document details the Hartford Hospital standard for determination of death using brain death criteria that is consistent with the two currently existing Connecticut statutes.

Statutory Background

**Uniform Determination of Death Act
(Adopted in Various Forms in a Number of States not yet 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 medical standards.

**Connecticut Determination of Death Statutes
Sec. 19a-279h(b)
(Procedure for Determining Death in Cases of Anatomical Donations)**

"Without limiting any other method of determining death, a donor may be pronounced dead if two physicians determine, in accordance with the usual and customary standards of medical practice, that the donor has suffered a total and irreversible cessation of all brain function. A total and irreversible cessation of all brain function shall mean that the heart and lungs of the donor cannot function, and are not functioning, without artificial supportive measures."

**Sec. 19a-504a(b)
(Relating to Removal of Life Support Systems)**

"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. Determination of death shall be made in accordance with accepted medical standards."

Standard for Determination of Death

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

Definitions

For the purposes of this policy, an "attending physician certified to determine brain death" as required by the Medical Staff of Hartford Hospital shall be defined as a Board Eligible/Certified Neurologist, Intensivist, Anesthesiologist, Surgeon or Neurosurgeon on the Hartford Hospital Medical Staff certified as qualified for these determinations by their departments/divisions. House staff 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, 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 two separate examinations 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) with documentation of the appropriate supporting medical data in the patient's chart. Two certified physicians must be present at the time of the second examination, and it is preferable that an attending physician performs the second examination following which the time of death and other relevant details are recorded 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 Examinations

The two examinations will be separated by an interval of at least 6 hours. A confirmatory test is not required unless anatomic abnormalities preclude a complete evaluation. The following conditions may interfere with the clinical diagnosis of brain death:

- Severe facial trauma
- Pre-existing pupillary abnormalities
- Toxic levels of any sedative drugs, aminoglycosides, tricyclic antidepressants, anticholinergics, antiepileptic drugs, chemotherapeutic agents, or neuromuscular blocking agents
- Sleep apnea or severe pulmonary disease resulting in chronic retention of CO₂

C) Documentation

The notation in the chart at both examinations should contain important baseline information and pertinent negatives. A checklist is provided in the Appendix.

The Determination of Death by Brain Death Criteria

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, AND...

There is cerebral unreceptivity and unresponsiveness as evidenced by total unresponsiveness to environmental stimuli. There will be no spontaneous movement, no posturing to noxious stimuli, nor will there be any vegetative response to painful stimulus. 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 brainstem function:

- Spontaneous movements of limbs other than pathologic flexion or extension response
- 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. BRAINSTEM FUNCTIONS ARE ABSENT...

Pupillary light, corneal, oculocephalic, oculovestibular, oropharyngeal, and respiratory (apnea) reflexes should be tested. When these reflexes cannot be adequately assessed, because of anatomical deformity, a confirmatory test is required. Adequate testing for apnea is required.

(i) Pupils

Mydriatic agents should not be used; if present the criteria for anatomic deformity apply. The pupils will be fixed in diameter and will not respond to sharp changes of light intensity.

(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 anatomic deformity apply.

(iii) Oropharyngeal

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.

(v) Oculovestibular Reflex

Oculovestibular (caloric) responses will not be present. In adults and children the procedure will be the instillation of at least 100 cc of ice water in the ear after otoscopic inspection has insured that the external auditory canal is patent and that the stimulus can reach the tympanum. The test will be performed on both sides with the lapse of at least five 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 at the **second** examination by the physician and Respiratory Care Practitioner as follows:

Patient's body temperature should be greater than 35 C° and serum potassium within normal limits (3.4-5.0).

Draw an arterial blood sample to ensure that PaCO₂ is between 35 to 40 mmHg and that pH is between 7.25 and 7.45. If the blood gas shows that these values are not within these ranges, make necessary ventilator adjustments and/or administration of NaHCO₃ and repeat arterial blood gas sample. The Respiratory Care Practitioner will set up the equipment and calculate the goal EtCO₂ 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% CO₂ and 97% O₂) and adjust the ventilator to SIMV mode with a rate of 4 breaths per minute. Change the sensitivity on the ventilator to P_{sens} of 2. Monitor the increase in EtCO₂ while observing the patient and ventilator screen for spontaneous respiratory efforts. The IMV rate may be decreased gradually by 1 breath/minute if the EtCO₂ has not increased incrementally or is not likely to reach the calculated EtCO₂ goal within 10 minutes. Draw an arterial blood sample when the calculated EtCO₂ is reached and then return the patient to previous ventilatory settings and discontinue the flow of Carbogen. If the PaCO₂ exceeds 55mmHg in the absence of spontaneous respiratory efforts, then the patient fulfills the requirements for apnea. In the event of cyanosis or a 10% or greater change in blood pressure or pulse over baseline values, the test should be terminated after an arterial blood sample is drawn.

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 ALL BRAIN FUNCTIONS PERSISTS FOR AN APPROPRIATE PERIOD OF OBSERVATION AND/OR TRIAL OF THERAPY.

Even when coma is known to have started at an earlier time, the absence of all brain functions must be established at the initiation of the observation period.

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 ten 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 bolus cerebral angiography and gamma camera imaging with 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 flow 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 patients may not have temporal insonation windows.

Test of Electrical Activity

Electrocerebral silence verifies 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 brainstem 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.

COMPLICATING CONDITIONS

A. 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 the 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. In cases where there is any likelihood of sedative presence, toxicology screening for all likely drugs is required. If exogenous intoxication is found, death may not be declared until the intoxicant is metabolized.

Total paralysis may cause unresponsiveness, areflexia, and apnea that closely simulates 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 pseudo-cholinesterase 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 10 mg per ml, the above guidelines may be used to establish brain death on a clinical basis. Barbiturate level of greater than 10 mg per ml precludes the declaration of brain death.

Some severe illnesses (e.g., hepatic encephalopathy, hyperosmolar coma, and preterminal uremia) can cause deep coma. Before irreversible cessation of brain functions can be determined, metabolic abnormalities should be considered and, if possible, corrected. Confirmatory tests of circulation or EEG may be necessary.

B. Hypothermia

Criteria for reliable recognition of death are not available in the presence of hypothermia (below 32°C core temperature [90°F]). 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 the issue is to restore normothermia. Hypothermia is not a common cause of difficulty in the determination of death.

C. Shock

Physicians 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 mean arterial blood pressure shall be 70 mm Hg or greater; pressure less than this level shall be indicative of shock. This may be accomplished with use of volume expanders or with pressor agents such as dopamine.

Issued:	April 1992
Proponent:	Chairperson, Neurology Department
Approved by:	Medical Staff Executive Committee, HH Policy & Procedure Committee
Review date:	June 1995, March 1997, December 1997, March 2000, Feb 2001,
Revised:	2002, December 2005
Cross Reference:	Policy Concerning Do Not Resuscitate (DNR) Orders

Appendix

Checklist for fulfillment of the criteria for brain death / guidelines for the structure of the death note for adults. See the criteria for children.

[The note should contain this language:]

FIRST EXAM

Date: _____

Time: _____

Blood pressure or MAP: _____

Body Temperature: _____

Age: _____

Name of examiner: _____

Background

[Full written statements should be made regarding each of these items.]

Cause of coma: _____

Statement that there is/is not cause to suspect that sedatives/narcotics are influencing the examination.

Statement that there is/is not cause to suspect that neuromuscular blockade is influencing the examination.

State that there are no known medical conditions to influence the examination.

Statement that there is no known fracture or anatomical deformity which would interfere with interpretation of physical findings (e.g. basilar skull fracture).

Barbiturate level if relevant _____

SECOND EXAM

Date: _____

Time: _____

Time elapsed since first exam: _____

Blood pressure or MAP: _____

Body Temperature: _____

Results of confirmatory test, if applicable. _____

Names: _____

FIRST AND SECOND EXAMS

[The note in chart should contain results explicitly, either written out or presented as a table such as this]

	Result
Pupils	_____
Corneal Reflex	_____
Cough or Gag	_____
Oculocephalic	_____
Oculovestibular	_____ (after _____ ml ice water)
Response to pain	_____
Muscle tone	_____
Apnea test	_____