POLICY

In accordance with the Pennsylvania Uniform Determination of Death Act, an individual is dead after sustaining either: (1) irreversible cessation of circulatory and respiratory functions; or (2) irreversible cessation of all functions of the entire brain, including the brain stem. The determination of death must be made by two clinical examinations including an apnea test, in accordance with acceptable medical standards.

PURPOSE

An individual with irreversible cessation of all brain function, including the brain stem, is dead. The purpose of this policy is to define the medical criteria that are to be used in the determination of death of a patient due to irreversible cessation of functioning of the entire brain (death by neurologic criteria). It is not intended to replace the judgment of a physician regarding futility of care in an acute situation.

SCOPE

The policy applies to all patients of the Hospital of the University of Pennsylvania.

IMPLEMENTATION

Chairman of the Medical Board, chairmen of clinical departments, Attending Physicians and House Staff Physicians licensed in Pennsylvania are to implement this policy.

PROCEDURE

Determination of Irreversible Cessation of all Functions of the Entire Brain in Adults, Including the Brain Stem

DIAGNOSTIC CRITERIA

The clinical diagnostic criteria in sections A, B, and C below must be met to declare death by neurologic criteria. Where indicated, the clinical diagnosis may be confirmed by “confirmatory studies”.

A. Prerequisites: brain death is the complete absence of function of the whole brain when the proximate cause is known and demonstrably irreversible.

1. Clinical and/or neuroimaging evidence of an acute central nervous system catastrophe that is compatible with the clinical diagnosis of brain death. For coma of unknown cause, additional investigation is necessary (see Section D).
2. Exclusion of complicating medical conditions that may confound the clinical assessment (no severe electrolyte, acid-base, endocrine, or nutritional disturbance).
3. Toxicological screening, when appropriate, and no evidence of drug intoxication or poisoning. Specific levels of central nervous system (CNS) depressants that might complicate the examination are left to clinical judgment.
4. Demonstrated absence of neuromuscular blockade if the patient had recent or prolonged use of neuromuscular blocking drugs.
5. Core body temperature > 32° C (90° F) and no circulatory shock (MAP (mean arterial pressure) > 55 mmHg) present.

B. The three cardinal features of brain death are coma or unresponsiveness; absence of brainstem reflexes; and apnea.

1. Coma or unresponsiveness as determined by the absence of any cerebrally mediated motor responses to pain in all extremities (nail-bed pressure) and supraorbitally.
2. Absence of brainstem reflexes:
   a) Pupils
      i. No response to bright light
      ii. Size: from midposition (4 mm) to dilated (9 mm)
   b) Ocular movement
      i. No oculocephalic reflex (testing only when no fractures or instability of the cervical spine is apparent)
      ii. No deviation of the eyes to irrigation in each ear with 50 ml of ice water (observe for 1 minute after each irrigation and at least 5 minutes between testing on each side)
   c) Facial motor response to stimulation
      i. No corneal response to touch
      ii. No jaw reflex
      iii. No facial grimacing to deep pressure on nail bed, supraorbital ridge, or temporomandibular joint
   d) Pharyngeal and tracheal reflexes
      i. No response to stimulation of the posterior pharynx
      ii. No cough response to bronchial suctioning
3. Apnea – formal apnea testing must be performed (see Criteria Form for procedure)

C. Irreversibility is determined by two examinations that meet the clinical criteria for brain death that are performed at least 6 hours apart. This interval may be shortened to 3 hours if a confirmatory study is performed.

D. Coma of unknown cause:

Coma of unknown cause (e.g., no evidence of brain trauma, stroke, hypoxic/hypotensive injury) requires a diligent search for the cause of coma before brain death determination. Special care must be taken to perform toxicology studies. In addition;

1. The interval between examinations that are consistent with the clinical criteria for brain death must be at least 24 hours apart.
2. A confirmatory neuroimaging study that demonstrates the absence of cerebral blood flow must be performed
SUBJECT: POLICY REGARDING DETERMINATION OF DEATH BY NEUROLOGIC CRITERIA

E. Conditions that may interfere with the diagnosis of brain death:

The following conditions may interfere with the clinical diagnosis of brain death, so that the diagnosis cannot be made with certainty on clinical grounds alone. In such cases, confirmatory tests are recommended.

1. Severe facial trauma
2. Preexisting pupillary abnormalities
3. Toxic levels of any sedative drugs, aminoglycosides, tricyclic antidepressants, anticholinergics, antiepileptic drugs, or chemotherapeutic agents
4. States of chronic retention of carbon dioxide (PaCO2)

DOCUMENTATION

1. The attached form “Certification of Death by Neurologic Criteria” (Criteria Form) must be completed prior to certification of death. All applicable items must be marked “Yes” in order for brain death to be declared. The completed Criteria Form is to remain part of the patient’s Medical Record.

   The cause and irreversibility of coma should be determined and documented as a first step in the process.

2. It is also standard to document the following:
   a. absence of complicating conditions
   b. absence of responsiveness to pain
   c. absence of brainstem reflexes
   d. absence of respiration with PCO2 > 60 mmHg (or 20 mmHg rise from baseline)
   e. result of confirmatory test (if performed)
   f. repeat neurologic examination

3. When the patient meets all the criteria on the Criteria Form, the attending physician or the covering attending must be notified. The form should be signed by the physician who completes the second clinical exam. This physician may not be a member of the transplant team. The time when the Criteria Form is signed is the legal time of pronouncement of death.

EXAMINATION PROCEDURES

1. Two clinical examinations must be performed. The examinations may be by the same physician, or two different physicians. At least one of the exams must be performed by an attending neurologist or neurosurgeon. The other exam must be performed by an attending neurologist/neurosurgeon, or the chief resident in neurosurgery, or an intensivist whose non-core privileges include determination of brain death. When the second sequential exam is done by an attending neurologist/neurosurgeon, the first exam may be done by a PGY 2 or higher in neurology/neurosurgery.

2. Both exams must be performed while the patient is in the Hospital of the University of Pennsylvania.

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ISSUED BY: /s/ C. William Hanson, III, M.D.
3. Interval between exams
   a. There must be AT LEAST 6 HOURS between the two clinical examinations unless a
      confirmatory laboratory test is done.
   b. If a confirmatory test shows evidence of death by neurologic criteria, the interval between the
      first and second clinical exam can be shortened to THREE HOURS. The confirmatory test
      should be done between the first and second exam. The second clinical examination must be
      completed and documented even if the confirmatory test results are consistent with brain death.

4. The clinical examination may be affected by the following complicating conditions: a) severe
   hypothermia (<32º C or 90º F); b) circulatory shock (MAP <55 mmHg); c) drug intoxication; d) severe
   endogenous metabolic intoxication; i.e., renal or hepatic failure; and e) prolonged effects of
   neuromuscular blocking agents. Prior to certification of death by neurological criteria, the
   complicating conditions of hypothermia, circulatory shock, metabolic intoxication, and prolonged
   effects of neuromuscular blocking agents must be excluded from being clinically significant.

5. Drug intoxication can mimic clinical signs of death by neurological criteria and may result in
   electrocerebral silence on an electroencephalogram. Examples of such drugs include barbiturates,
   benzodiazepines, methaqualone, meprobamate and trichlorethylene. If such drugs have been
   administered, their blood levels must not be clinically significant in the clinical judgment of all
   attending physicians involved prior to certification of death by neurological criteria.

CONFIRMATORY TESTS

1. Brain death is a clinical diagnosis. These ancillary tests are not required for the determination of
   death by neurologic criteria.

2. A confirmatory laboratory test is required:
   a. In situations in which specific components of clinical testing cannot reliably be performed
      or evaluated. This includes patients with ocular/facial trauma, preexisting pupillary
      abnormalities or conditions associated with chronic retention of CO₂ - precluding full
      clinical assessment of brainstem function.
   b. If the interval of observation between the two neurologic exams required for brain death
      determination is less than 6 hours.

3. The preferred confirmatory test is a nuclear isotope blood flow scan. Alternatively, conventional
   four vessel cerebral angiography or electroencephalography (EEG) can be used.

OTHER CONSIDERATIONS

1. Determination of death by neurologic criteria is, by law, a medical responsibility and, therefore,
   consent of the family is not needed nor should it be requested. However, the responsible physicians
   should inform the family regarding the patient’s grave prognosis at least by the start of the certifying
   process, and continue to keep the family informed throughout the process. Early and clear
   communication, as well as sensitivity for the family, is important during this time to prepare the family
   for cessation of continued medical therapy; e.g., removal of the mechanical ventilator from the
deceased, which event should occur after certification of death by neurologic criteria. This removal following determination of death does not require the permission of the family.

2. Medical Examiner cases undergo the identical processes for certification and cessation of medical therapy. (see policy # 1-6-11, “Procedures Following Patient Death.”)

**Determination of Irreversible Cessation of all Functions of the Entire Brain, Including the Brain Stem in Neonates**

The neonate cannot be declared dead by neurologic criteria until after five (5) days of age. After that time and up to sixty (60) days of age, the interval between clinical examinations must be at least 48 hours, and a confirmatory test must be done at the beginning and end of the interval.

**Organ Donation**

In accordance with HUP policy “Organ Donation and Anatomical Donation and Pennsylvania’s Anatomical Gift Act,” the Organ Procurement Agency (Gift of Life) should be notified when the brain death protocol is initiated.

**SOURCES AND REFERENCES:**


5. 35 P.S. Section 10201

6. Developed, reviewed, and approved by:
   Ad Hoc Ethics Subcommittee
   Ethics Committee
   Office of Legal Affairs
   Associate Chair of Protocol and Policy of the Medical Board
   Executive Committee of the Medical Board: February 1994 and March 1994
   Medical Board: 21 March 1994
   Ad Hoc Policy Review Group: March 2005
   Office of the General Counsel: March 2005
   Medical Board: September 28, 2005
**SUBJECT:** POLICY REGARDING DETERMINATION OF DEATH BY NEUROLOGIC CRITERIA

**Effective:** 10/15/05

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Give specific information as requested below and answer "Yes" or "No."

**B. Is the cause of the coma known and sufficient to account for irreversible loss of brain function?**

Note: Coma of unknown cause requires a diligent search for the cause of coma, at least 24 hours between the examinations, and a confirmatory test that demonstrates absence of cerebral blood flow.

**C. Complicating Conditions Were Excluded**

1. Hypothermia is not present  
   a. core body temperature must be >32°C or 90°F
2. Drug intoxication has been excluded  
   a. toxicology screening, if appropriate
   b. specific levels of CNS depressants that might complicate the examination are left to clinical judgment
3. Circulatory shock is not present (MAP < 55 mmHg)
4. Severe endogenous metabolic (renal, hepatic, electrolyte, endocrine, acid-base, and vitamin) deficiency or intoxication has been excluded
5. Neuromuscular paralyzing drug effect has been excluded

**D. Unresponsiveness Documented**

1. Response to painful stimuli is absent
2. Spontaneous movements are absent, aside from spinal reflexes

Note: Deep tendon reflexes, including plantar flexor reflexes noted in the legs, are compatible with brain death. Purposeful movement or posturing precipitates the diagnosis of brain death.

3. Locked-in state is excluded (testing of vertical eye movements)

**E. Loss of Brain Stem Function Documented**

1. Pupils are unresponsive to bright light (usually 4-9 mm)
2. Corneal reflexes are absent
3. Oculocephalic reflexes are absent  
   (no eye movement to doll’s eye maneuver)
4. Oculovestibular reflexes are absent  
   (no eye deviation to 50 ml of ice water in each ear canal)
5. Gag response to tracheal stimulation is absent

Signature of First Examiner __________________________ Date ____________

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**ISSUED BY:** /s/ C. William Hanson, III, M.D.
F. The Apnea Test

Date _____ Time _____ Physician Examiner (Print) _____

a. Initial PaCO₂ (must be 35-45 mmHg) _____
b. Final PaCO₂ _____
c. For patients with chronic CO₂ retention, pre-test and final pH _____

Comments:
1. Apnea test showed no respiratory movements with the necessary CO₂ rise and pH fall? _____
2. Apnea test results are documented on page 37 _____

Signature _____

For the examiner performing the second neurologic examination: Have one of the following four criteria (I, II, III, or IV) been established?

Mark ONE as “YES”:

I. Items B to E have been confirmed by two examinations separated by at least six hours, and item F, the apnea test, validates the clinical diagnosis of brain death.

II. In the event of a shortened interval between clinical exams
   1. Items B to E have confirmed as YES, and
   2. A confirmatory study is consistent with brain death and it has been documented, and
   3. A second exam at least three hours after the first, confirms items A to E as YES, and the apnea test validates the clinical diagnosis of brain death.

III. In the event that E or F cannot be fully determined because the injury or condition precludes evaluation (e.g., facial injury precluding caloric testing, apnea test is indeterminate due to chronic CO₂ retention), then the following apply:
   1. ALL items that are assessable are YES, and
   2. No cerebral blood flow is present by nuclear medicine cerebral blood flow scan or 4 vessel angiography, and it has been documented, and
   3. A second examination at least 3 hours after the first, confirms all assessable items as YES, and
   4. The apnea test validates the clinical diagnosis of brain death (except for those individuals whose apnea test is indeterminate)

IV. In the case of coma of unknown cause, and item B cannot be fully determined, then the following apply:
   1. A thorough search for the cause of coma has been performed, including toxicological studies and neuroimaging of the brain, and
   2. Items C to E have been confirmed as YES, and
   3. No cerebral blood flow is present by nuclear medicine cerebral blood flow scan or 4 vessel angiography, and it has been documented on page 3, and
   4. A second examination at least 24 hours after the first, confirms all assessable items as YES, and the apnea test validates the clinical diagnosis of brain death.

CERTIFICATION of Brain Death by Second Examiner

On the basis of the finding recorded above, indicating irreversible loss of function of the entire brain as described in hospital policy, I certify that patient _____ is dead.

DATE _____ TIME _____ PHYSICIAN SIGNATURE* M.D. NAME PRINTED M.D.

*This record must be signed by the physician who has conducted the second clinical examination of the patient and certifies him/her to be dead.

Note: If organ donation is contemplated, the physician who certifies brain death cannot participate in the procedure for removing or transplanting the organ.
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