Proposed Guidelines for Brain Death Determination
in the State of Indiana

ADULT DIAGNOSTIC CRITERIA –

PATIENTS ABOVE 18 YEARS OF AGE

I. Diagnostic criteria for clinical diagnosis of brain death

A. Prerequisites. Brain death is the absence of clinical brain function when the proximate cause is known and demonstrably irreversible.

1. Clinical or neuroimaging evidence of an acute CNS catastrophe that is compatible with the clinical diagnosis of brain death

2. Exclusion of complicating medical conditions that may confound clinical assessment (no severe electrolyte, acid-base, or endocrine disturbance)

3. No drug intoxication or poisoning

4. Core temperature $\geq 32^\circ C$ (90$^\circ F$)

B. The three cardinal findings in brain death are coma or unresponsiveness, absence of brainstem reflexes, and apnea.

1. Coma or unresponsiveness—no cerebral motor response to pain in all extremities (nail-bed pressure and supraorbital pressure)

2. Absence of brainstem reflexes
   a) Pupils
      i. No response to bright light
      ii. Size: midposition (4 mm) to dilated (9 mm)
b) Ocular movement
   
   i. No oculocephalic reflex (testing only when no fracture or instability of the cervical spine is apparent)
   
   ii. No deviation of the eyes to irrigation in each ear with 50 ml of cold water (allow 1 minute after injection and at least 5 minutes between testing on each side)

c) Facial sensation and facial motor response
   
   i. No corneal reflex to touch with a throat swab
   
   ii. No jaw reflex
   
   iii. No grimacing to deep pressure on nail bed, supraorbital ridge, or temporomandibular joint

d) Pharyngeal and tracheal reflexes
   
   i. No response after stimulation of the posterior pharynx with tongue blade
   
   ii. No cough response to bronchial suctioning
3. Apnea—testing performed as follows:

   a) Prerequisites
      i. Core temperature $\geq 36.5^\circ$ C or $97^\circ$ F
      ii. Systolic blood pressure $\geq 90$ mm Hg
      iii. Euvolemia. *Option:* positive fluid balance in the previous 6 hours
      iv. Normal PCO$_2$. *Option:* arterial PCO$_2$ $\geq 40$ mm Hg
      v. Normal PO$_2$. *Option:* preoxygenation to obtain arterial PO$_2$ $\geq 200$ mm Hg

   b) Connect a pulse oximeter and disconnect the ventilator.

   c) Deliver 100% $O_2$, 6 l/min, into the trachea. *Option:* place a cannula at the level of the carina.

   d) Look closely for respiratory movements (abdominal or chest excursions that produce adequate tidal volumes).

   e) Measure arterial PO$_2$, PCO$_2$, and pH after approximately 8 minutes and reconnect the ventilator.

   f) If respiratory movements are absent and arterial PCO$_2$ is $\geq 60$ mm Hg (*option:* 20 mm Hg increase in PCO$_2$ over a baseline normal PCO$_2$), the apnea test result is positive (i.e., it supports the diagnosis of brain death).

   g) If respiratory movements are observed, the apnea test result is negative (i.e., it does not support the clinical diagnosis of brain death), and the test should be repeated.

   h) Connect the ventilator if, during testing, the systolic blood pressure becomes $\leq 90$ mm Hg or the pulse oximeter indicates significant oxygen desaturation and cardiac arrhythmias are present; immediately draw an arterial blood sample and analyze arterial blood gas. If PCO$_2$ is $\geq 60$ mm Hg or PCO$_2$ increase is $\geq 20$ mm Hg over baseline normal PCO$_2$, the apnea test result is positive (it supports the clinical diagnosis of brain death); if PCO$_2$ is $< 60$ mm Hg
or PCO$_2$ increase is <20 mm Hg over baseline normal PCO$_2$, the result is indeterminate, and an additional confirmatory test can be considered.

II. Pitfalls in 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. Confirmatory tests are recommended.

A. Severe facial trauma

B. Preexisting pupillary abnormalities

C. Toxic levels of any sedative drugs, aminoglycosides, tricyclic antidepressants, anticholinergics, antiepileptic drugs, chemotherapeutic agents, or neuromuscular blocking agents

D. Sleep apnea or severe pulmonary disease resulting in chronic retention of CO$_2$. 
III. Clinical observations compatible with the diagnosis of brain death

These manifestations are occasionally seen and should not be misinterpreted as evidence for brainstem function.

A. Spontaneous movements of limbs other than pathologic flexion or extension response

B. Respiratory-like movements (shoulder elevation and adduction, back arching, intercostals expansion without significant tidal volumes)

C. Sweating, blushing, tachycardia

D. Normal blood pressure without pharmacologic support or sudden increases in blood pressure

E. Absence of diabetes insipidus

F. Deep tendon reflexes; superficial abdominal reflexes; triple flexion response

G. Babinski reflex

IV. Confirmatory laboratory tests (Options)

Brain death is a clinical diagnosis. A repeat clinical evaluation 6 hours later is recommended, but this interval is arbitrary. A confirmatory test is not mandatory but is desirable in patients in whom specific components of clinical testing cannot be reliably performed or evaluated. It should be emphasized that any of the suggested confirmatory tests may produce similar results in patients with catastrophic brain damage who do not (yet) fulfill the clinical criteria of brain death. The following confirmatory test findings are listed in the order of the most definitive test first. Consensus criteria are identified by individual tests.

A. Conventional angiography. No intracerebral filling at the level of the carotid bifurcation or circle of Willis. The external carotid circulation is patent, and filling of the superior longitudinal sinus may be delayed.
B. Electroencephalography. No electrical activity during at least 30 minutes of recording that adheres to the minimal technical criteria for EEG recording in suspected brain death as adopted by the American Electroencephalographic Society, including 16-channel EEG instruments.

C. Transcranial Doppler ultrasonography

1. Ten percent of patients may not have temporal insonation windows. Therefore, the initial absence of Doppler signals cannot be interpreted as consistent with brain death.

2. Small systolic peaks in early systole without diastolic flow or reverberating flow, indicating very high vascular resistance associated with greatly increased intracranial pressure.

D. Technetium-99m hexamethylpropyleneamineoxime (HMPAO or Ceretec) or Technetium 99m (ethyl cysteinate dimmer (ECD, Bicisate or Neurolite) brain perfusion scintigraphy; otherwise known as isotope flow study with brain scan.

No flow to brain and no uptake of isotope in brain parenchyma (hollow skull phenomenon) is consistent with brain death.

E. Somatosensory evoked potentials. Bilateral absence of N20-P22 response with median nerve stimulation. The recordings should adhere to the minimal technical criteria for somatosensory evoked potential recording in suspected brain death as adopted by the American Electroencephalographic Society.
V. Medical record documentation *(Standard)*

- A. Etiology and irreversibility of condition
- B. Absence of brainstem reflexes
- C. Absence of motor response to pain
- D. Absence of respiration with $\text{PCO}_2 \geq 60$ mm Hg
- E. Justification for confirmatory test and result of confirmatory test
- F. Optional: Repeat neurologic examination. The interval is arbitrary, but a 6-hour period is reasonable.
- G. Document repeat neurological examination if performed.