

RESOLUTION 17-04

**PROPOSED REVISIONS OF ISMA BRAIN DEATH
GUIDELINES**

Introduced by: Emil Weber, MD

Action: Adopted as Amended

RESOLVED, that ISMA adopt updated brain death guidelines for adults and children, as provided by the Ad Hoc Committee to establish Brain Death Guidelines for the state of Indiana for 2017.

Proposed Revision of ISMA Adult Brain Death Guidelines of 2017

ADULT GUIDELINES FOR DETERMINATION OF BRAIN DEATH

<p>ADULT DIAGNOSTIC CRITERIA- PATIENTS ABOVE 18 YEARS OF AGE</p> <p>I. Diagnostic criteria for clinical diagnosis of brain death.</p> <p>A. Prerequisites. Brain death is the absence of clinical brain function when the proximate cause is known and demonstrably irreversible.</p> <ol style="list-style-type: none">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 $\geq 32^{\circ}\text{C}$ (90°F).5. In any patient who has a recorded core body temperature of 34°C or lower, prior to or during hospitalization, a cerebral blood flow study must be performed which shows no cerebral blood flow before brain death can be declared by physical examination. A core body temperature of 36°C or higher should be maintained for at least 24 hours prior to initiating the brain death examination. <p>B. The three cardinal findings in brain death are coma or unresponsiveness,</p>	<p>3. Apnea-testing performed as follows:</p> <p>a) Prerequisites</p> <ol style="list-style-type: none">I. Core temperature $\geq 36^{\circ}\text{C}$ or 97°FII. Systolic blood pressure $\geq 90\text{ mm Hg}$III. Euvolemia. Option: positive fluid balance in the previous 6 hoursIV. Normal pCO_2, <i>Option</i>: arterial $\text{pCO}_2 \geq 40\text{ mm Hg}$V. Normal pO_2. <i>Option</i>: preoxygenation to obtain arterial $\text{pO}_2 \geq 200\text{ mm Hg}$ <p>b) Connect a pulse oximeter and disconnect the ventilator.</p> <p>c) .</p> <p>c) If oxygen saturation falls to 85 % or less, abort the apnea test and reconnect the respirator; otherwise, continue with apnea test.</p> <p>d) Look closely for respiratory movements (abdominal or chest excursions that produce adequate tidal volumes).</p> <p>e) Measure arterial pO_2, pCO_2 and pH after approximately 8 minutes and reconnect the ventilator.</p> <p>f) If respiratory movements are absent and arterial pCO_2 is $> 60\text{ mm Hg}$</p>
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<p>absence of brainstem reflexes and apnea.</p> <ol style="list-style-type: none"> 1. Coma or unresponsiveness-no cerebral motor response to pain in all extremities (nail-bed pressure and supraorbital pressure). 2. Absence of brainstem reflexes <ol style="list-style-type: none"> a) Pupils <ol style="list-style-type: none"> i. No response to bright light ii. Size: midposition (4mm) to dilated (9mm). b) Ocular movement <ol style="list-style-type: none"> i. No oculoccephalic 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 <ol style="list-style-type: none"> 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 <ol style="list-style-type: none"> i. No response after stimulation of the posterior pharynx with tongue blade ii. No cough response to bronchial suctioning 	<p>(option: 20 mm Hg increase in pCO₂ over a baseline normal pCO₂), the apnea test result is positive (i.e., it supports the diagnosis of brain death).</p> <p>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.</p> <p>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 pCO₂ is \geq 60 mm Hg or pCO₂ increase is $<$ 20 mm Hg over baseline normal pCO₂, the result is indeterminate, and an additional confirmatory test can be considered.</p> <p>C. Brain Death Declaration in Patients Who Cannot Be Examined.</p> <p>In patients who cannot be examined to determine brain death because of severe injuries to the face and head or because of high levels of sedative drugs, brain death can be declared after a cerebral arteriogram or isotope cerebral blood flow study demonstrates</p>
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unequivocally there is no blood flow to the brain. This study must be read by two (2) radiologists certified in the interpretation of cerebral blood flow studies.

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

GUIDELINES FOR DETERMINATION OF BRAIN DEATH

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, anti-cholinergics, antiepileptic drugs, chemotherapeutic agents, or neuromuscular blocking agents
- D. Sleep apnea or severe pulmonary disease resulting in chronic retention of CO₂
- E. Pregnancy is a special situation

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 dimer (ECD, Biscate 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 pCO₂ > 60 mm Hg
- E. Justification for confirmatory test and result of confirmatory test
- F. Optional: Repeat neurologic examination. The interval is arbitrary, but a six-hour period is reasonable.
- G. Document repeat neurological examination if performed.

See Checklist for Determination of Brain Death on back.

Checklist for Determination of Brain Death in Patients 18 Years of Age or Older in the State of Indiana

Patient's Name: _____ Room No: _____ Medical Record No: _____

Patient's Age: _____ Sex: Male ☐ Female ☐ Attending Physician: _____, MD, DO

Has the cause of patient's present neurological state been determined? Yes ☐ No ☐

Have metabolic diseases or toxins been ruled out by history? Yes ☐ No ☐

Exclude: Hypothermia, Hypotension, depressant medication and correctable metabolic imbalance.

Temperature: Fahrenheit _____ or Centigrade _____ Blood Pressure: _____ mm. Hg

Barbiturate level and Depressant Medication Survey:

Blood drawn: Date: _____ Time: _____ Barbiturate Level: _____

Significant levels of other depressants: Yes ☐ No ☐

Movements	Present (✓)	Absent (✓)
Spontaneous		
Evoked		
Pectoral pinch		
Pressure on supraclavicular ridge		
Pressure on sternum		
Pressure on tibia		
Reflexes	Right Pupil	Left Pupil
Pupils - Size:	mm.	mm.
Reaction to light	Yes (✓) No (✓)	Yes (✓) No (✓)
Reaction to facial pinch		
Corneal Reflex		
Response to head turning (Doll's Eye Maneuver)	Right Eye Yes (✓) No (✓)	Left Eye Yes (✓) No (✓)
Response to ice water stimulation (50 ml. each ear 3 min. apart)		
Pontomedullary Reflexes	Yes (✓)	No (✓)
1. Chewing movements		
2. Tongue movements		
3. Gag reflex		
4. Jaw jerk		
5. Response to loud noise		
Apnea Test	Any Breath Taken Yes (✓)	Any Breath Taken No (✓)
Patient's temperature must be at least 36.5° C (97° F) to perform this test.		
1st Date _____ Time _____		
Arterial pCO ₂ <u>before</u> disconnection _____		
Arterial pCO ₂ <u>after</u> disconnection _____		
2nd Date (if needed) _____ Time _____		
Arterial pCO ₂ <u>before</u> disconnection _____		
Arterial pCO ₂ <u>after</u> disconnection _____		
CONFIRMATORY TESTS, if needed - Results		
Is the patient brain dead?	Yes <input type="checkbox"/> (✓)	No <input type="checkbox"/> (✓)

Date: _____ Time: _____ Signed: _____, MD, DO

Pediatric Brain Death Diagnostic Criteria – 37 Weeks Gestational Age to 18 Years of Age

Only qualified physicians caring for seriously ill neonatal patients under one year of age should establish brain death in patients under one year of age.

Issues to be considered and protocol to be followed relating to brain death examination:

1. Determination of brain death in neonates, infants, and children relies on a clinical diagnosis that is based on the absence of neurologic function with a known irreversible cause of coma. Coma and apnea must coexist to diagnose brain death. This diagnosis should be made by physicians who have evaluated the history and completed the neurologic examinations.
2. Prerequisites for initiating a brain death evaluation:
 - a. Hypotension, hypothermia, and metabolic disturbances that could affect the neurologic examination must be corrected before examination for brain death.
 - b. Sedatives, analgesics, neuromuscular blockers, and anticonvulsant agents should be discontinued for a reasonable time period based on elimination half-life of the pharmacologic agent to ensure they do not affect the neurological examination. Knowledge of the total amount of each agent (mg/kg) administered since hospital admission may provide useful information concerning the risk of continued medication effects. Blood or plasma levels to confirm high or supratherapeutic levels of anticonvulsants with sedative effects that are not present should be obtained (if available) and repeated as needed or until the levels are in the low to midtherapeutic range. See Medications sheet, Appendix A.
 - c. The diagnosis of brain death based on neurologic examination alone should not be made if supratherapeutic or high therapeutic levels of sedative agents are present. When levels are in the low or in the midtherapeutic range, medication effects sufficient to affect the results of the neurologic examination are unlikely. If uncertainty remains, an ancillary study should be performed. In patients who cannot be examined, refer to # 6 of Physical Examination To Determine Brain Death section in the Guidelines For the Determination of Brain Death in Infants and Children in the State of Indiana.
 - d. Assessment of neurologic function may be unreliable immediately after cardiopulmonary resuscitation or other severe acute brain injuries and evaluation for brain death should be deferred for a minimum of 24 hours if there are concerns or inconsistencies in the examination.
 - e. In any patient who has a recorded core body temperature of 34 °C or less, prior to or during hospitalization, a cerebral blood flow study must be performed which shows no cerebral blood flow before brain death can be declared by physical examination. A core body temperature of 35° C or greater should be maintained for at least 24 hours prior to initiating brain death examinations.
3. Number of examinations, examiners, and observation periods:
 - a. Two examinations including apnea testing with each examination separated by an observation period are required.
 - b. The examinations should be performed by different attending physicians involved in the care of the child. The apnea test may be performed by the same physician, preferably the attending physician who is managing ventilator care of the child.
 - c. Recommended observation periods:
 1. Twenty-four hours for neonates (37 weeks gestation to term infants 30 days of age)
 2. Twelve hours for infants and children (>30 days to 18 years)

- d. The first examination determines the child has met neurologic examination criteria for brain death. The second examination, performed by a different attending physician, confirms that the child has fulfilled criteria for brain death.
 - e. Physicians attesting to brain death cannot be part of the organ procurement team.
4. Apnea testing:
- a. Apnea testing must be performed safely and requires documentation of an arterial Paco_2 20 mm Hg above the baseline Paco_2 and ≥ 60 mm Hg with no respiratory effort during the testing period to support the diagnosis of brain death. Some infants and children with chronic respiratory disease or insufficiency may only be responsive to supranormal Paco_2 levels. In this instance, the Paco_2 level should increase to ≥ 20 mm Hg above the baseline Paco_2 level.
 - b. If the apnea test cannot be performed as a result of a medical contraindication or cannot be completed because of hemodynamic instability, desaturation to $<85\%$, or an inability to reach a Paco_2 of ≥ 60 mm Hg, an ancillary study should be performed.
5. Ancillary studies:
- a. Ancillary studies (electroencephalography, cerebral angiography, and radionuclide cerebral blood flow) are not required to establish brain death unless the clinical examination or apnea test cannot be completed.
 - b. Radionuclide cerebral blood flow study must be performed with a lipophilic isotope. Both dynamic and static phases of the study must be performed. Two of these isotopes available in the United States are:
 - 1. Technetium – 99m hexamethylpropylene-amineoxime (HMPAO or Ceretec)
 - 2. Technetium – 99m ethyl cysteinate dimer (ECD, Bicisate, or Neurolite)
 - c. An EEG (electroencephalogram) demonstrating electrocerebral silence in the absence of other causative factors (i.e. drugs) is supportive of brain death.
 - d. Ancillary studies are not a substitute for the neurologic examination.
 - e. It must be recognized that both EEG and cerebral blood flow studies are less sensitive and less reliable in infants <30 days of age. A cerebral blood flow may be preferred over EEG in this age group.
 - f. For all age groups, ancillary studies can be used to assist the clinician in making the diagnosis of brain death to reduce the observation period or when 1) components of the examination or apnea testing cannot be completed safely as a result of the underlying medical condition of the patient; 2) if there is uncertainty about the results of the neurologic examination; or 3) if a medication effect may interfere with evaluation of the patient. If the ancillary study supports the diagnosis, the second examination and apnea testing can then be performed. When an ancillary study is used to reduce the observation period, all aspects of the examination and apnea testing should be completed and documented.
 - g. When an ancillary study is used because there are inherent examination limitations (i.e., 1-3 in 5d), then components of the examination done initially should be completed and documented.
 - h. If the ancillary study is equivocal or if there is concern about the validity of the ancillary study, the patient cannot be pronounced dead. The patient should continue to be observed until brain death can be declared on clinical examination criteria and apnea testing or a follow-up ancillary study can be performed to assist with the determination of brain death. A waiting period of 24 hours is recommended before further clinical re-evaluation or repeat ancillary study is performed. Supportive patient care should continue during this time period.
6. Declaration of death
- a. The time of death is declared after the second clinical examination and apnea test are completed and confirm brain death.
 - b. When ancillary studies are used, documentation of components from the second clinical examination that can be completed must remain consistent with brain death. All aspects of the clinical examination, including the apnea test, or ancillary studies must be appropriately documented.

PHYSICAL EXAMINATION TO DETERMINE BRAIN DEATH

Reversible conditions or conditions that can interfere with the neurologic examination must be excluded before brain death testing.

1. Coma.

The patient must exhibit complete loss of consciousness, vocalization, and volitional activity.

Patients must lack all evidence of responsiveness. Eye opening or eye movement to noxious stimuli is absent.

Noxious stimuli should not produce a motor response other than spinally mediated reflexes. The clinical differentiation of spinal responses from retained motor responses associated with brain activity requires expertise.

2. Loss of all brain stem reflexes, including:

Midposition or fully dilated pupils which do not respond to light.

Absence of pupillary response to a bright light is documented in both eyes.

Usually the pupils are fixed in a midsize or dilated position (4-9mm).

When uncertainty exists, a magnifying glass should be used.

Absence of movement of bulbar musculature including facial and oropharyngeal muscles.

Deep pressure on the condyles at the level of the temporomandibular joints and deep pressure at the supraorbital ridge should produce no grimacing or facial muscle movement.

Absent gag, cough, sucking, and rooting reflex.

The pharyngeal or gag reflex is tested after stimulation of the posterior pharynx with a tongue blade or suction device. The tracheal reflex is most reliably tested by examining the cough response to tracheal suctioning. The catheter should be inserted into the trachea and advanced to the level of the carina followed by one or two suctioning passes.

Absent corneal reflexes.

Absent corneal reflex is demonstrated by touching the cornea with a piece of tissue paper, a cotton swab, or squirts of water. No eyelid movement should be seen. Care should be taken not to damage the cornea during testing.

Absent oculovestibular reflexes.

The oculovestibular reflex is tested by irrigating each ear with ice water (caloric testing) after the patency of the external auditory canal is confirmed. The head is elevated to 30 degrees. Each external auditory canal is irrigated (one ear at a time) with approximately 10-50mL of ice water. Movement of the eyes should be absent during 1 minute of observation. Both sides are tested with a minimum interval of five (5) minutes.

3. Apnea.

The patient must have the complete absence of documented respiratory effort (if feasible) by formal apnea attesting demonstrating a $\text{Paco}_2 \geq 60$ mm Hg and ≥ 20 mm Hg increase above baseline.

Normalization of the pH and Paco_2 measured by arterial blood gas analysis, maintenance of core temperature $>35^\circ\text{C}$, normalization of blood pressure appropriate for the age of the child, and correcting for factors that could affect respiratory effort are a prerequisite to testing.

The patient should be preoxygenated using 100% oxygen for 5-10 minutes before initiating this test.

Intermittent mandatory mechanical ventilation should be discontinued once the patient is well oxygenated and a normal Paco_2 has been achieved.

The patient's heart rate, blood pressure, and oxygen saturation should be continuously monitored while observing for spontaneous respiratory effort throughout the entire procedure.

Follow-up blood gases should be obtained at 5-10 minute intervals to monitor the rise in Paco_2 while the patient remains disconnected from mechanical ventilation.

If no respiratory effort is observed from the initiation of the apnea test to the time the measured $\text{Paco}_2 \geq 60$ mm Hg and ≥ 20 mm Hg above the baseline level, the apnea test is consistent with brain death.

The patient should be placed back on mechanical ventilator support and medical management should continue until the second neurologic examination and apnea test confirming brain death is completed.

If oxygen saturations fall $<85\%$, hemodynamic instability limits completion of apnea testing, or a Paco_2 level of ≥ 60 mm Hg cannot be achieved, the infant or child should be placed back on ventilator support with appropriate treatment to restore normal oxygen saturations, normocarbia, and hemodynamic parameters. Another attempt to test for apnea may be performed at a later time or an ancillary study may be pursued to assist with determination of brain death.

Evidence of any respiratory effort is inconsistent with brain death and the apnea test should be terminated.

4. Flaccid tone and absence of spontaneous or induced movements, excluding spinal cord events such as reflex withdrawal or spinal myoclonus.

The patient's extremities should be examined to evaluate tone by passive range of motion assuming that there are no limitations to performing such an examination (e.g., previous trauma, etc.) and the patient observed for any spontaneous or induced movements.

If abnormal movements are present, clinical assessment to determine whether these are spinal cord reflexes should be done.

5. Brain Death Declaration.

After the second physical examination demonstrates no brain life, the patient is brain dead and is to be declared brain dead at that time.

6. Brain Death Declaration in Patients Who Cannot be Examined

In patients who cannot be examined to determine brain death because of severe injuries to the face and head or because of high levels of sedative drugs, brain death can be declared after a cerebral arteriogram or isotope cerebral blood flow study demonstrates unequivocally no blood flow to the brain. This study must be read by two (2) radiologist certified in the interpretation of cerebral blood flow studies.

**DRUG ELIMINATION TABLE TO SERVE AS REFERENCE FOR PRACTITIONERS
WHEN DEALING WITH PATIENTS RECEIVING SPECIFIC PHARMACOLOGICAL AGENTS
AND WHO ARE UNDERGOING BRAIN DEATH TESTING**

Appendix A

MEDICATIONS ADMINISTERED TO CRITICALLY ILL PEDIATRIC PATIENTS AND RECOMMENDATIONS FOR TIME INTERVAL TO TESTING AFTER DISCONTINUATION OF MEDICATIONS		
Medication	Infants/Children Elimination Half-Life	Neonates Elimination Half-Life
Intravenous induction, anesthetic, and sedative agents Thiopental Ketamine Etomidate Midazolam Propofol Dexmedetomidine	Adults: 3-11.5 hrs (shorter half life in children) 2.5 hrs 2.6-3.5 hrs 2.9-4.5 hrs 2-8 mins, terminal half-life 200 mins (range, 300-700 mins) Terminal half-life 83-159 mins	4-12 hrs Infants have faster clearance
Antiepileptic drugs Phenobarbital Pentobarbital Phenytoin Diazepam Lorazepam Clonazepam Valproic acid Levetiracetam	Infants: 20-133 hrs* Children 37-73 hrs* 25 hrs* 11-55 hrs* 1 mo. to 2 yrs: 40-50 hrs 2-12 yrs: 15-21 hrs 12-16 yrs: 18-20 hrs Infants: 40.2 hrs (range 18-73 hrs) Children: 10.5 hrs (range 6-17 hrs) 22-33 hrs Children >2 months: 7-13 hrs* Children 2-14 yrs: mean 9 hrs; range, 3.5-20 hrs Children 4-12 yrs: 5 hrs	45-500 hrs* 63-88 hrs* 50-95 hrs 40 hrs 10-67 hrs*
Intravenous narcotics Morphine sulfate Meperidine Fentanyl Sufentanil	Infants 1-3 months: 6.2 hrs (5-10 hrs) 6 months to 2.5 yrs: 2.9 hrs (1.4-7.8 hrs) Children: 1-2 hrs Infants <3 months: 8.2-10.7 hrs (range, 4.9-31.7 hrs); Infants 3-18 months: 2.3 hrs Children: 5-8 yrs: 3 hrs 5 months to 4.5 yrs: 2.4 hrs (mean); 0.5-14 yrs: 21 hrs (range, 11-36 hrs for long-term infusions) Children 2-8 yrs: 97 + 42 mins	7.6 hrs (range, 4.5-13.3 hrs) 23 hrs (range, 12-39 hrs) 1-15 hrs 382-1,162 mins
Muscle relaxants Succinylcholine Pancuronium Vecuronium Atracurium Rocuronium	5-10 mins; prolonged duration of action in patients with pseudocholinesterase deficiency or mutation 110 mins 41 mins 17 mins 3-12 months: 1.3 ± 0.5 hrs 1 to <3 yrs: 1.1 ± 0.7 hrs 3 to <8 yrs: 0.8 ± 0.3 hrs Adults: 1.4-2.4 hrs	65 mins 20 mins
<p>*Elimination half-life does not guarantee therapeutic drug levels for longer-acting medications or medications with active metabolites. Drug levels should be obtained to ensure that levels are in a low to midtherapeutic range before neurologic examination to determine brain death. In some instances, this may require waiting several half-lives and rechecking serum levels of the medication before conducting the brain death examination.</p> <p>Metabolism of pharmacologic agents may be affected by organ dysfunction, age, patient condition, and hypothermia. Physicians should be aware of total amounts of administered medication that can affect drug metabolism and levels.</p>		

Checklist for Documentation of Brain Death in Infants and Children
Two physicians must perform independent examinations separated by specified intervals.

Age of Patient	Timing of First Exam	Inter-exam, Interval
Term newborn 37 weeks gestational age and up to 30 days old	<input type="checkbox"/> First exam may be performed 24 hours after birth OR following cardiopulmonary resuscitation or other severe brain injury.	<input type="checkbox"/> At least 24 hours <input type="checkbox"/> Interval shortened because ancillary study (Section 4) is consistent with brain death
31 days to 18 years	<input type="checkbox"/> First exam may be performed 24 hours following cardiopulmonary resuscitation or other severe brain injury	<input type="checkbox"/> At least 12 hours OR <input type="checkbox"/> Interval shortened because ancillary study (Section 4) is consistent with brain death

Section 1. PREREQUISITES for brain death examination and apnea test

A. IRREVERSIBLE AND IDENTIFIABLE Cause of Coma (Please check)

☐ Traumatic brain injury ☐ Anoxic brain injury ☐ Known metabolic disorder ☐ Other (specify) _____

B. Correction of contributing factors that can interfere with the neurologic examination

	Examination One	Examination Two
a. Core body temp is over 95°F (35°C)	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
b. Systolic blood pressure or MAP in acceptable range (systolic BP not less than 2 standard deviations below age appropriate norm) based on age	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
c. Sedative/analgesic drug effect excluded as a contributing factor	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
d. Metabolic intoxication excluded as a contributing factor	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
e. Neuromuscular blockade excluded as a contributing factor	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> If ALL prerequisites are marked YES, then proceed to Section 2, OR		
<input type="checkbox"/> Confounding variable was present. Ancillary study was therefore performed to document brain death (Section 4)		

Section 2. Physical Examination (Please check)

Note: SPINAL CORD REFLEXES ARE ACCEPTABLE.

	Examination One Date / Time	Examination Two Date / Time
a. Flaccid tone, patient unresponsive to deep painful stimuli	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
b. Pupils are midposition or fully dilated and light reflexes are absent	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
c. Corneal, cough, gag reflexes are absent	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
d. Sucking and rooting reflexes are absent (in neonates and infants)	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
e. Oculovestibular reflexes are absent	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
f. Spontaneous respiratory effort while on mechanical ventilation is absent	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> The _____ (specify) element of the exam could not be performed because _____		
Ancillary study (EEG or radionuclide (CBF) was therefore performed to document brain death (Section 4).		

Section 3. APNEA Test

	Examination One Date / Time	Examination Two Date / Time
No spontaneous respiratory efforts were observed despite final PaCO ₂ ≥ 60 mm Hg and a ≥ 20 mm Hg increase above baseline. (Examination One)		
No spontaneous respiratory efforts were observed despite final PaCO ₂ ≥ 60 mm Hg and a ≥ 20 mm Hg increase above baseline. (Examination Two)		
Apnea test is contraindicated or could not be performed to completion because _____		
Ancillary study (EEG or radionuclide CBF) was therefore performed to document brain death (Section 4).		

Section 4. ANCILLARY testing		Date / Time
Ancillary testing is required when: <ol style="list-style-type: none"> 1. Any components of the examination or apnea testing cannot be completed; 2. If there is uncertainty about the results of the neurologic examination; or 3. If a medication effect may be present. 		
Ancillary testing can be performed to reduce the inter-examination period; however, a second neurologic examination is required. Components of the neurologic examination that can be performed safely should be completed in close proximity to the ancillary test.		
<input type="checkbox"/> Electroencephalogram (EEG) report documents electrocerebral silence OR	<input type="checkbox"/> Yes <input type="checkbox"/> No	
<input type="checkbox"/> Cerebral Blood Flow (CBF) study report documents no cerebral perfusion	<input type="checkbox"/> Yes <input type="checkbox"/> No	

Section 5. Signatures			
Examiner One			
I certify that my examination is consistent with cessation of function of the brain and brainstem. Confirmatory exam to follow.			
(Specialty)	(Printed Name)	(Signature)	(Time)
	(Pager # /License #)	(Date mm/dd/yyyy)	

Examiner Two			
I certify that my examination <input type="checkbox"/> and/or ancillary test report <input type="checkbox"/> confirms unchanged and irreversible cessation of function of the brain and brainstem. The patient is declared brain dead at this time.			
Date/Time of death: _____			
(Printed Name)		(Signature)	
(Specialty)	(Pager # /License #)	(Date mm/dd/yyyy)	(Time)

COMATOSE CHILD - 37 weeks gestation to 18 years of age

Brain Death Determination Algorithm

Does Neurologic Examination Satisfy Clinical Criteria for Brain Death?		
<p>A. Physiologic parameters have been normalized:</p> <ol style="list-style-type: none"> 1. Normothermic: Core Temp. $>35^{\circ}\text{C}$ (95°F) 2. Normotensive for age without volume depletion <p>B. Coma: No purposeful response to external stimuli (exclude spinal reflexes)</p> <p>C. Examination reveals absent brainstem reflexes: Pupillary, corneal, vestibuloocular (Caloric), gag.</p> <p>D. Apnea: No spontaneous respirations with a measured $\text{pCO}_2 \geq$ to 60 mm Hg or ≥ 20 mm Hg above the baseline PaCO_2</p>		
NO		YES
<p>A. Continue observation and management</p> <p>B. Consider diagnostic studies; baseline EEG, and imaging studies</p>		
NO	Toxic, drug or metabolic disorders have been excluded.	
<p>A. Await results of metabolic studies and drug screen</p> <p>B. Continued observation and reexamination</p>		YES
<p>Patient Can Be Declared Brain Dead (by age-related observation periods)</p> <p>A. <u>Newborn 37 weeks gestation to 30 days:</u> Examinations 24 hours apart remain unchanged with persistence of coma, absent brainstem reflexes and apnea. Ancillary testing with EEG or CBR studies should be considered if there is any concern about the validity of the examination.</p> <p>B. <u>30 days to 18 years:</u> Examinations 12 hours apart remain unchanged. Testing with EEG or CBF studies should be considered if there is any concern about the validity of the examination.</p> <p>Ancillary studies (EEG & CBF) are not required but can be used when (1) components of the examination or apnea testing cannot be safely completed; (2) there is uncertainty about the examination; (3) if a medication effect may interfere with evaluation or (4) to reduce the observation period.</p>		

The content of these Brain Death Guidelines is largely excerpted from an article published in *Critical Care Medicine* 2011 Vol. 39, No. 9, entitled "Guidelines for the determination of brain death in infants and children; An update of the 1987 Task Force recommendations." For documentation and supportive information, including an extensive bibliography, please refer to the aforementioned publication.