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March 22, 2010

Dear Doctor:

The Indiana State Medical Association House of Delegates reviewed and adopted guidelines for the establishment of brain death at its annual meeting last September.

Neurosurgeon Emil Weber, M.D., Regional Medical Director for the Indiana Organ Procurement Organization (IOPO) in Evansville, introduced the guidelines which were the product of an ad hoc committee of knowledgeable physicians\* gathered to review the most authoritative information on brain death available in the world today.

The intent of these guidelines is to provide a consistent guide for treating physicians, next of kin and/or legal representatives to make the best possible end-of-life decisions. A valid clinical brain death protocol also supports the potential for organ donation and aids greatly in expediting this process.

While most physicians do not confront issues of brain death determination in day-to-day patient care, reference guidelines will serve as a valuable tool to help direct when necessary; they provide accurate diagnostic information for patient care decision-making.

A copy of the guidelines is enclosed. Pediatric guidelines for the establishment of brain death are not included, but should be available following review by the ISMA later this year. If you have questions as you review the Brain Death Guidelines, please contact:

Emil L. Weber, M.D., 10135 Browning Road, Evansville IN 47725.

Sincerely,

Frederick R. Ridge, M.D.

President, Indiana State Medical Association

*\*Review panel included: James D. Fleck, M.D., Neurologist, Indiana University Medical Center; Paul R. Helft, M.D., Oncologist-Ethicist, Indiana University Medical Center, Director, Fairbanks Center for Medical Ethics; Terry G. Horner, M.D., Neurosurgeon, Indianapolis Neurosurgical Group, Inc.; Michael R. Niemeier, M.D., Pulmonary Disease and Critical Care Medicine Specialist, Respiratory and Critical Care Consultants; Emil L. Weber, M.D., Neurosurgeon and Regional Medical Director for the Indiana Organ Procurement Organization.*

*Consulting physicians: W. Rueben Cohen, M.D., Pediatric Critical Care Intensivist, Evansville; Bunni Okanlami, M.D., Pediatrician, Medical Director, Pediatric ICU at Memorial Hospital, South Bend.*

# GUIDELINES FOR DETERMINATION OF BRAIN DEATH

## 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  $\geq 32^{\circ}\text{C}$  ( $90^{\circ}\text{F}$ )

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  $\geq 36.5^{\circ}\text{C}$  or  $97^{\circ}\text{F}$
  - ii. Systolic blood pressure  $\geq 90\text{mm Hg}$
  - iii. Euvolemia. *Option:* positive fluid balance in the previous 6 hours
  - iv. Normal  $\text{pCO}_2$ . *Option:* arterial  $\text{pCO}_2 \geq 40\text{ mm Hg}$
  - v. Normal  $\text{pO}_2$ . *Option:* preoxygenation to obtain arterial  $\text{pO}_2 \geq 200\text{ mm Hg}$
- b) Connect a pulse oximeter and disconnect the ventilator.
- c) Deliver 100%  $\text{O}_2$ , 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  $\text{pO}_2$ ,  $\text{pCO}_2$ , and pH after approximately 8 minutes and reconnect the ventilator.
- f) If respiratory movements are absent and arterial  $\text{pCO}_2$  is  $> 60\text{ mm Hg}$  (*option:* 20 mm Hg increase in  $\text{pCO}_2$  over a baseline normal  $\text{pCO}_2$ ), 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  $\leq 90\text{ mm Hg}$  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  $\text{pCO}_2$  is  $\geq 60\text{ mm Hg}$  or  $\text{pCO}_2$  increase is  $\geq 20\text{ mm Hg}$  over baseline normal  $\text{pCO}_2$ , the apnea test result is positive (it supports the clinical diagnosis of brain death); if  $\text{pCO}_2$  is  $< 60\text{ mm Hg}$  or  $\text{pCO}_2$  increase is  $< 20\text{ mm Hg}$  over baseline normal  $\text{pCO}_2$ , 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

# 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 CO<sub>2</sub>
- 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 pCO<sub>2</sub> > 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

| <b>Movements</b>               | Present (✓) | Absent (✓) |
|--------------------------------|-------------|------------|
| Spontaneous                    |             |            |
| Evoked                         |             |            |
| Pectoral pinch                 |             |            |
| Pressure on supraciliary ridge |             |            |
| Pressure on sternum            |             |            |
| Pressure on tibia              |             |            |

| <b>Reflexes</b>  | 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)                   |             |        |            |        |
| Response to ice water stimulation (50 ml. each ear 3 min. apart) |             |        |            |        |

| <b>Pontomedullary Reflexes</b> | Yes (✓) | No (✓) |
|--------------------------------|---------|--------|
| 1. Chewing movements           |         |        |
| 2. Tongue movements            |         |        |
| 3. Gag reflex                  |         |        |
| 4. Jaw jerk                    |         |        |
| 5. Response to loud noise      |         |        |

| <b>Apnea Test</b>  | Any Breath Taken<br>Yes (✓) | Any Breath Taken<br>No (✓) |
|--|-----------------------------|----------------------------|
| Patient's temperature must be at least 36.5° C (97° F) to perform this test. |                             |                            |
| 1st Date _____ Time _____  |                             |                            |
| Arterial pCO <sub>2</sub> <u>before</u> disconnection _____                  |                             |                            |
| Arterial pCO <sub>2</sub> <u>after</u> disconnection _____                   |                             |                            |
| 2nd Date (if needed) _____ Time _____  |                             |                            |
| Arterial pCO <sub>2</sub> <u>before</u> disconnection _____                  |                             |                            |
| Arterial pCO <sub>2</sub> <u>after</u> disconnection _____                   |                             |                            |

| <b>CONFIRMATORY TESTS, if needed – Results</b> |
|--|
|  |
|  |

**Is the patient brain dead?** Yes  (✓) No  (✓)

Date: \_\_\_\_\_ Time: \_\_\_\_\_ Signed: \_\_\_\_\_, MD, DO