The Diagnosis of Brain Death

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What is death?

Cessation of life
What is life?

• Aggregate of vital phenomena
• Obscure principle whereby organized beings are peculiarly endowed with certain powers and functions
  • Organization
  • Irritability
  • Movement
  • Growth
  • Reproduction
  • Adaptation
Criteria for Determining Death

- Traditional
  - Irreversible Cessation of Cardiac and Respiratory function
- Concept of Brain Death
  - Since 1968
14 Billions Neurons
Diagnosis of Death by Neurologic Criteria

  - Death can be determined by neurologic criteria
Brain Death vs. Severe Brain Damage

- **Brain Death** = Life support is useless
  - Traditional Death Criteria will occur in the future despite medical support

- **Severe Brain Damage**
  - Vegetative State
  - Akinetic Mutism
  - Life can be sustained without immediate death threat
Evolution of Criteria for Brain Death

- 23 patients who had lost consciousness, brain stem reflexes and respiration with flat EEG (Rev Neurol 1959; 101: 3-5).
Evolution of Criteria for Brain Death (cont.)

1968 - Ad Hoc Committee at Harvard Medical School reexamined the definition of brain death and defined irreversible coma, or brain death, as unresponsiveness and lack of receptivity, the absence of movement and breathing, the absence of brain-stem reflexes, and coma whose cause has been identified (JAMA 1968; 205: 337-40).
1971 – Mohandas and Chou described damage to the brain stem as a critical component of severe brain damage (J Neurorurg 1971; 35: 211-8).
Evolution of Criteria for Brain Death (cont.)

1976 – Conference of Medical Royal Colleges and their Faculties in the United Kingdom published a statement which defined brain death as complete, irreversible loss of brain-stem function (BMJ 1976;2:1187-8).
Evolution of Criteria for Brain Death (cont.)

1981 – President’s Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research recommended the use of confirmatory tests to reduce the duration of the requisite period of observation but recommended a period of 24 hours for patients with anoxic damage.
1995 – American Academy of Neurology conducted an evidence-based review and suggested practice measures. This report specifically addressed the tools of clinical examination and the validity of confirmatory tests (Neurology 1995;45:1012-4).
Brain Death

The President’s Committee for the Study of Ethical Problems in Medicine defined death as:

- Irreversible cessation of circulatory and respiratory function
- Irreversible cessation of all functions of the entire brain, including brain stem

Clinical and electroencephalographic criteria permit the reliable diagnosis of brain death.
Differential Diagnosis

- Intoxications
- Metabolic Disorders
- Locked-in syndrome
- Guillain-Barre syndrome
- Head Injury
- Hypothermia
Causes of Brain Death

- In children: abuse is more common than MVA or asphyxia.
- In adults: chief cause are traumatic brain injury and subarachnoid hemorrhage.
The Clinical Examination

- The standard for the determination of brain death
The Clinical Examination

- Series of careful neurological tests
- Establishment of cause of coma
- Ascertainment of irreversibility
- Resolution of any misleading clinical neurologic signs
- Recognition of possible confounding factors
- Interpretation of neuroimaging
- The performance of any confirmatory tests that are deemed necessary
Prerequisites for Clinical Exam of Brain Death

- Establishment of cause of coma
Prerequisites for Clinical Exam of Brain Death

- Rule out confounding factors (i.e. electrolytes, acid-base disturbances, endocrine disturbance).
Prerequisites for Clinical Exam of Brain Death
Rule out

- Severe Hypotension
- Severe Hypothermia (Core temperature < 32°C)
Prerequisites for Clinical Exam of Brain Death Rule Out

- Absence of evidence of drug intoxication, poisoning or neuromuscular blocking agents.
The Clinical Examination in Brain Death

- CT scan is essential for determining the cause of brain death (mass with brain herniation, multiple hemispheric lesions, edema).
- CSF sampling in cases of CNS infection should reveal diagnostic findings.
**Table 1. Clinical Criteria for Brain Death in Adults and Children.**

<table>
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<tr>
<th>Coma</th>
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<tbody>
<tr>
<td>Absence of motor responses</td>
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<tr>
<td>Absence of pupillary responses to light and pupils at midposition with respect to dilatation (4–6 mm)</td>
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<tr>
<td>Absence of corneal reflexes</td>
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<td>Absence of caloric responses</td>
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<td>Absence of gag reflex</td>
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<tr>
<td>Absence of coughing in response to tracheal suctioning</td>
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<tr>
<td>Absence of sucking and rooting reflexes</td>
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<td>Absence of respiratory drive at a PaCO₂ that is 60 mm Hg or 20 mm Hg above normal base-line values*</td>
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Interval between two evaluations, according to patient’s age

| Term to 2 mo old, 48 hr |  |
| >2 mo to 1 yr old, 24 hr |  |
| >1 yr to <18 yr old, 12 hr |  |
| ≥18 yr old, interval optional |  |

Confirmatory tests†

| Term to 2 mo old, 2 confirmatory tests |  |
| >2 mo to 1 yr old, 1 confirmatory test |  |
| >1 yr to <18 yr old, optional |  |
| ≥18 yr old, optional |  |
Apnea Testing

- $pCO_2$ 60mmHg or a value that is 20mmHg higher than the normal base-line value (Willatts SM, Drummond G. Anesthesia 2000; 55:676-7).
- Preoxygenation: $FIO_2$ 100% x $\geq$ 10 minutes
- $O_2$ catheter at carina at 6ml/min
- The increase in partial pressure of $CO_2$ at 3mmHg/ min.
- 8-10 minutes off ventilator
Confirmatory Tests

- Optional in adults
- Recommended in children younger than one year old
- In several European, Central and South America and Asian countries confirmatory testing is required by law
## Table 2. Confirmatory Testing for a Determination of Brain Death.

**Cerebral angiography**
The contrast medium should be injected under high pressure in both anterior and posterior circulation.
No intracerebral filling should be detected at the level of entry of the carotid or vertebral artery to the skull.
The external carotid circulation should be patent.
The filling of the superior longitudinal sinus may be delayed.

**Electroencephalography**
A minimum of eight scalp electrodes should be used.
Interelectrode impedance should be between 100 and 10,000 Ω.
The integrity of the entire recording system should be tested.
The distance between electrodes should be at least 10 cm.
The sensitivity should be increased to at least 2 μV for 30 minutes with inclusion of appropriate calibrations.
The high-frequency filter setting should not be set below 30 Hz, and the low-frequency setting should not be above 1 Hz.
Electroencephalography should demonstrate a lack of reactivity to intense somatosensory or audiovisual stimuli.

**Transcranial Doppler ultrasonography**
There should be bilateral insonation. The probe should be placed at the temporal bone above the zygomatic arch or the vertebrobasilar arteries through the suboccipital transcranial window.
The abnormalities should include a lack of diastolic or reverberating flow and documentation of small systolic peaks in early systole. A finding of a complete absence of flow may not be reliable owing to inadequate transtemporal windows for insonation.

**Cerebral scintigraphy (technetium Tc 99m hexametazine)**
The isotope should be injected within 30 minutes after its reconstitution. A static image of 500,000 counts should be obtained at several time points: immediately, between 30 and 60 minutes later, and at 2 hours.
A correct intravenous injection may be confirmed with additional images of the liver demonstrating uptake (optional).
Isoelectric Electroencephalogram

Wijdicks, E.F.M., NEJM, 344, No.16, 2001
Transcranial Doppler

Dynamic Nuclear Scan in Brain Death

Wijdicks, E.F.M., NEJM, 344, No.16, 2001
Conclusions

- After the clinical criteria of brain death have been met, the physician should inform the next of kin, who can be approached about organ donation.
- The physician is required to abide by state law with respect to organ donation.
- In the United States, and Puerto Rico organ-procurement agencies must be notified to request donation of organs.