

# Guidelines

## Pediatric Brain Death Guidelines

Pediatric Braindeath Guidelines Group 2011

### Introduction

The diagnosis of Brain Death in children is generally regarded as being more difficult than in adults and there is considerable variation in the exact protocol followed in different countries, and even between different states in the same country. Nevertheless, the diagnostic procedure is essentially by clinical examination.

The following guidelines are based on multiple sources, including the American Academy of Pediatrics Guidelines for the determination of brain death in children<sup>1,4</sup>, the American Academy of Neurology evidence based guideline update 2010<sup>2</sup>, the Australian and New Zealand Intensive Care Society statement on death and organ donation, 2008<sup>3</sup> and the general consensus of the Guidelines committee of experts from India listed at the end of this article (Guidelines group was chaired and coordinated by Dr Balaramachandran in year 2011 and this consensus was compiled by him on behalf of the Guidelines group).

### Definition

Brain death is defined as irreversible cessation of all functions of the entire brain, including the brain stem

### Pre-requisites

The following conditions must be met before brain death can be determined:

1. There must be a recognized cause of coma sufficient to explain the irreversible cessation of all brain function. Both coma and apnea must coexist to declare brain death.
2. Potentially reversible causes of coma must be excluded

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- a. Hypothermia – core body temperature must be  $> 35^{\circ} \text{C}$ , since severely hypothermic patients may appear brain dead
  - b. Uncontrolled hypotension – the blood pressure must be normal for age (systolic BP not  $< 2 \text{SD}$  below norm for age)
  - c. Sedatives and other CNS depressant drugs / toxins – sufficient time must be allowed for any CNS depressant agents to be metabolized. If this cannot be assured, a drug level may be obtained, if possible, to show that the drug in question does not exceed the normal therapeutic levels.
  - d. If neuromuscular blocking agents have been administered, a peripheral nerve stimulator should be used to show that there is no residual neuromuscular blockade
  - e. Severe metabolic derangements must be excluded, including markedly abnormal plasma concentrations of glucose, sodium, potassium, phosphate, magnesium, calcium
  - f. Any other sign that suggests a potentially reversible cause of coma
3. Neurological assessment may be unreliable immediately following cardiopulmonary resuscitation or acute brain injury – brain death evaluation should be deferred by 24 hours in these circumstances.

### Clinical Examination

The diagnosis of brain death is essentially clinical. There must be absence of higher brain function – lack of consciousness  
There must be absence of brain stem functions

### NOTE

#### Observations that are compatible with brain death

- The following observations can be present in brain death

| Clinical testing   | Test procedure and response   | Comments   |
|--|---|--|
| Coma   | Apply noxious stimuli in the cranial nerve distribution and all four limbs and trunk. There should be no motor response   | See note below   |
| Pupillary light reflex-<br>cranial nerves II & III                           | Shine a bright light into each eye and look for pupillary constriction. There should be no pupillary constriction   | Pupils must be $\geq 4$ mm in diameter. A magnifying glass may be used, if required. Use of anti-cholinergic drugs, such as Atropine, can cause pupillary dilatation |
| Corneal reflex – cranial<br>nerves V & VII                                   | Touch the corneas with soft cotton wool. There should be no blinking or withdrawal reflex   | Touch only the lateral aspect of the cornea to avoid damage  |
| Absence of movement of<br>the bulbar musculature –<br>cranial nerves V & VII | Apply deep pressure over the condyles at the temporo-mandibular joints and over the supra-orbital ridges. There should be no grimacing or facial muscle movement  |  |
| Oculo-vestibular reflex –<br>cranial nerves III, IV, VI<br>& VIII            | Inspect the external auditory meatus with an otoscope to make sure that the ear drum is visible and intact – if required, clean any cerumen before proceeding. Elevate head to 30° and place in the neutral position. Instill 20 – 50 ml of iced water into the ear canal with a syringe. Hold both eyes open and observe for at least 1 minute. There should be no response – both eyes should remain in the mid-position. Wait 5 minutes and repeat test in the other ear | Fracture of the skull base or petrous temporal may obliterate the response on the side of the fracture.  |
| Gag reflex – cranial<br>nerves IX & X  | Stimulate the posterior pharyngeal wall on both sides with a tongue depressor. There should be no gag response  | May be difficult to examine in orally intubated patients   |
| Cough reflex - cranial<br>nerve X  | Stimulate the trachea with a suction catheter. There should be no cough   |  |
| Flaccidity   | Evaluate all extremities by passive range of motion (unless contra-indicated). There should be flaccid tone and no spontaneous or induced movements   | See note below   |

- Spinal reflexes in response to stimulation
- These may include movements of the upper limbs, deep tendon reflexes, plantar reflexes, respiratory like movements and head turning
- Sweating, blushing or tachycardia
- Normal blood pressure without pharmacological support
- Absence of diabetes insipidus

#### Observations that are incompatible with brain death

The following observations are incompatible with brain death:

- Decerebrate or decorticate posturing
- True extensor or flexor responses to painful stimuli
- Seizures

#### Number of tests and who should perform them

Two examinations (including two apnea tests) should be performed, separated by an interval. A different Consultant Physician who is taking care of the child should perform each clinical examination. These physicians should have specific expertise and experience in performing such assessment and can include Pediatric Intensivists, Neurologists, Anesthetists, Neurosurgeons or Pediatricians. The same individual may perform the apnea tests. In case the testing is being performed for the purposes of organ harvesting, additional requirements from the individual State Governments may apply (such as pre-registration and authorization of the physician performing the tests).

#### Demonstration of apnea

The role of the apnea test has been questioned recently<sup>5</sup>. Nevertheless, it continues to be a part of

the Brain Death testing protocol in most countries at this time. The apnea test must be performed twice (as part of each clinical exam), but may be performed by the same individual – preferably the physician who is managing the patient’s ventilator. The following section describes how to perform the apnea test.

The same pre-requisites apply as for performing the clinical tests – i.e. the patient should not be hypothermic, hypotensive or have a serious metabolic or endocrine disturbance. Additional contraindications include a high cervical spinal cord injury or very high oxygen / ventilatory requirements that will result in the inability to disconnect safely from the ventilator. If the apnea tests cannot be performed safely, then an ancillary test must be performed to determine brain death.

1. Pre-oxygenate the patient for 5 minutes with 100% oxygen.
2. The physician involved in certifying brain death should be physically present at the bedside during the test to attest to the presence of apnea.
3. Manipulate the ventilator to allow the PaCO<sub>2</sub> to rise to > 40 mm Hg – this baseline arterial CO<sub>2</sub> should be confirmed by blood gas analysis or end tidal CO<sub>2</sub>.
4. Monitor the patient during the test (ECG, blood pressure and SpO<sub>2</sub>) and stop the test if there is significant hypotension, desaturation or cardiac arrhythmia.
5. Disconnect the patient from the mechanical ventilator and insert an appropriately sized oxygen catheter into the endotracheal tube. Adjust the oxygen flow to deliver 100% oxygen at a flow rate between 2 – 6 L/min. Use only the minimum flow required to maintain adequate oxygen saturation. A T-piece or CPAP circuit can also be used to supply oxygen to the patient when disconnected from the ventilator.
6. After a period of apnea of between 5 – 10 minutes (depending on the PaCO<sub>2</sub> at the beginning of the test), perform an arterial blood gas. The PaCO<sub>2</sub> on the ABG should be ≥ 60 mm Hg and ≥ 20 mm Hg more than the baseline level. If the PaCO<sub>2</sub> does not meet these parameters, the test may be continued and the ABG repeated after 5 minutes, provided the patient continues to be stable.

7. Observe the patient continuously for the presence of any respiratory efforts. If any respiratory efforts are noted, abandon the test immediately. If there is complete apnea, note the duration of apnea and the PaCO<sub>2</sub> at the end of the test.

8. Reconnect the patient to the mechanical ventilator.

**Response:** In a brain dead patient, no respiratory efforts should be seen during the period of apnea.

### Ancillary Tests

Ancillary tests are not routinely required to determine brain death and are not a substitute for the clinical examination. However, they may be used in specific situations:

- a. When the apnea test cannot be performed safely
- b. If there is uncertainty regarding the results of the neurological examination
- c. If a medication may be present that would preclude declaration of brain death
- d. In order to reduce the waiting period between the two sets of tests

A number of ancillary tests are available.

### EEG

A digital EEG should be performed by a technician who has experience in performing EEG’s for the purposes of determining brain death. In general, the sensitivity should be increased to 2 µV, the high frequency filter should be set above 30 Hz and the low frequency filter set not above 1 Hz. A minimum of eight scalp electrodes should be used. The EEG should demonstrate a lack of reactivity to intense somatosensory and audiovisual stimulation.

### Tests to Assess Intracranial Blood Flow

The purpose of these tests is to show that there is no flow in the intracerebral vessels, due to occlusion of the vasculature by cerebral edema. The various techniques by which intracranial blood flow can be assessed include four vessel cerebral angiography, Radionuclide imaging, CT angiography, Magnetic Resonance angiography and Trans Cranial Doppler ultrasonography. Of these techniques, four-vessel cerebral angiography is regarded as the gold standard

and involves direct injection of contrast medium into both Carotid arteries and both Vertebral arteries.

Of all the confirmatory tests mentioned above, EEG is the most easily available test. Radionuclide cerebral blood flow assessment is also acceptable – the remainder are time consuming, not easily available, not always standardized, may require shifting an unstable patient and, in some cases, expensive.

Any one of the following tests may be used (depending on availability) when an ancillary test is required:

- i. EEG
- ii. Radionuclide cerebral blood flow assessment
- iii. Four vessel cerebral angiography.

### Time Course of Tests for Brain Death

- The clinical tests are performed twice, each time by a different physician
- The apnea test is performed twice – may be performed by the same physician
- Death is declared when the second neurological examination and apnea test confirm that the results of the first tests are unchanged and the changes are irreversible
- If an ancillary test performed after the first clinical examination/apnea test is consistent with brain death, then the second clinical examination / apnea test can be performed at any time

Table 1 below gives the time gap between the clinical tests.

| Age   | Clinical tests | Interval between tests | Ancillary tests |
|---|----------------|------------------------|-----------------|
| Term new born (> 37 weeks gestational age to 30 days) | As adult       | 24 hrs                 | If required     |
| 31 days – 18 years                                    | As adult       | 12 hrs                 | If required     |

### References

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