GUIDELINES FOR THE
DIAGNOSIS OF BRAIN DEATH

Recognizing the need for and the advisability of physicians' following recognized guidelines for the diagnosis of brain death, the CMA has studied the issue and endorsed the guidelines of the Canadian Congress of Neurological Sciences.

The development of techniques for the ventilatory and circulatory support of critically ill patients has created a need for new definitions of death. Although irreversible cessation of circulatory and respiratory functions acceptably defines death, irreversible cessation of brain function is also equivalent to death even though the heart continues to beat while the patient is on a respirator.

In 1968, following the publication of the Harvard Criteria for the diagnosis of brain death, the CMA provided guidelines that were revised in 1974 and 1975. In 1976, guidelines were established in the United Kingdom, and in 1981, revised guidelines were published in the Journal of the American Medical Association.

Brain death must be determined clinically by an experienced physician in accord with accepted medical standards. Thus, the guidelines described below are based on current medical information and experience. As knowledge advances, it can be anticipated that further revisions will become necessary. Because of the major consequences of the diagnosis of brain death, consultation with other physicians experienced in the relevant clinical examinations and diagnostic procedures is usually advisable.

Guidelines

The clinical diagnosis of brain death can be made when all the following criteria have been satisfied.

1. An etiology has been established that is capable of causing brain death and potentially reversible conditions have been excluded (see Comment 2, below).
2. The patient is in deep coma and shows no response within the cranial nerve distribution to stimulation of any part of the body. No movements such as cerebral seizures, dyskinetic movements, "decorticate" or decerebrate posturing arising from the brain are present (see 1a, below).
3. Brain-stem reflexes are absent (see 1b, below).
4. The patient is apneic when taken off the respirator for an appropriate time (see 1c, below).
5. The conditions listed above persist when the patient is reassessed after a suitable interval (see 2, below).

Comments

Although the purpose of this document is to state general principles and recommend guidelines rather than to outline a set of rules, certain features of the guidelines merit more detailed explanation.

1. Cessation of brain function. The clinical absence of brain function is defined as profound coma, apnea and the absence of brain-stem reflexes.
   a) Coma. The patient should be observed for spontaneous behaviour and response to noxious stimuli. In particular, there should be no motor response within the cranial nerve distribution to stimuli applied to any body regions. There should be no spontaneous or elicited movements (dyskinesias, "decorticate" or decerebrate posturing or epileptic seizures) arising from the brain. However, various spinal reflexes may persist in brain death.
   b) Brain-stem reflexes. Pupillary light and corneal, vestibulo-ocular and pharyngeal reflexes must be absent. The pupils should be midsize or larger and must be unreactive to light. Care should be taken that atropine or related drugs that could block the pupillary response to light have not been given to the patient. The vestibulo-ocular reflexes should be tested with caloric stimulation while the head is 30° above the horizontal. In adults a minimum of 120 ml of ice water should be used. Grimacing or any other motor response to pharyngeal or tracheal suctioning is incompatible with brain death.
   c) Apnea. Apnea was originally defined as lack of respiration when the patient was disconnected from the respirator for 3 minutes. This failed to consider whether an adequate PaCO2 level was present to trigger respiration. The PaCO2 threshold for respiratory stimulation in comatose patients may be elevated to as high as 50 to 55 mm Hg, and many patients on respirators have low PaCO2 levels that rise slowly (e.g., 2 to 3 mm Hg/min) when the respirator is stopped. In patients who fulfill the other clinical criteria of brain death, apneic oxygenation, described below, is a safe way of testing respiratory activity.

If blood gas determinations are available, the PaCO2 should be 40+/−5 mm Hg before testing for apnea begins. The patient should be preoxygenated (but not hyperventilated) with 100% oxygen for 10 minutes before testing. The respirator is then disconnected for 10 minutes while, to prevent hypoxemia, 100% oxygen is delivered at 6 L/min through an endotracheal cannula. This should produce a sufficient rise in PaCO2 to serve as a respiratory stimulant.

If blood gas determinations are not available, an adequate test of brain-stem responsiveness to hypercarbia can be provided by ventilating the patient for 10 minutes with a 95%
oxygen/5% carbon dioxide mixture before the 10-minute apneic oxygenation. In patients with severe respiratory disease, it is advisable to obtain the opinion of a respiratory physician to determine the safety and validity of this test for apnea.

Testing for apnea without passive oxygenation is not recommended. In addition to its potential deleterious effects on the brain, the resultant hypoxemia can occasionally cause complex movements of the limbs and trunk, presumably owing to spinal cord ischemia, that could be confused with reflex movements of cerebral origin.

2. Irreversibility. Cessation of brain function is determined to be irreversible when potentially reversible causes have been excluded and the changes are judged to be permanent. Drug intoxication (particularly of barbiturates, sedatives and hypnotics), treatable metabolic disorders, hypothermia (core temperature less than 32.2°C), shock and peripheral nerve or muscle dysfunction due to disease or neuromuscular-blocking drugs must be excluded.

Re-evaluation is essential to ensure that the nonfunctioning state of the brain is persistent and to reduce the possibility of observer error. Depending on the etiology, the interval between such examinations may be as short as 2 hours or as long as 24 hours; observation for at least 24 hours is usually recommended to confirm brain death due to anoxia/ischemia (e.g., postcardiac arrest). In situations where brain death is declared for purposes of organ transplantation, local regulations may stipulate specific intervals for reassessment.

Special circumstances

1. Infants and children. Brain death has not been sufficiently well studied in neonates, infants and your children to determine whether the clinical criteria listed above apply to these groups.

2. Inability to apply the clinical criteria. Some clinic situations such as uncertainty regarding etiology, inability to examine one or both eyes due to trauma, middle ear injuries, cranial neuropathies or severe pulmonary disease may preclude the valid application of the listed clinical criteria. In these circumstances, the only reliable means of confirming brain death is the absence of cerebral perfusion determined by cerebral angiography or radionuclide scintigraphy.

Laboratory tests

Although brain death can be established reliably by clinical criteria alone, special tests can be used to support and in some instances supplement the clinical diagnosis. The electroencephalogram assesses cerebral cortical function. Electroencephalogram inactivity is confirmation of brain death only if all the clinical criteria apply, and if established techniques are followed to ensure proper sampling of cortical activity. Visual, auditory and somatosensory evoked responses or other tests may eventually prove to be useful, but, at present, there are no standard guidelines for their use in assessing patients with suspected brain death.

The absence of intracranial perfusion, demonstrable by cerebral angiography or radionuclide scintigraphy, is reliable evidence of brain death. The mean arterial pressure should be greater than 80 mm Hg when cerebral perfusion is assessed. If cerebral angiography or radionuclide scintigraphy is used to determine the absence of cerebral perfusion, the procedure should be performed by an appropriately qualified specialist.

The above set of guidelines was prepared by a subcommittee of the Canadian Congress of Neurological Sciences and has been approved by the membership of the Canadian Neurological Society, the Canadian Neurosurgical Society, the Canadian Association for Child Neurology and the Canadian Society of Clinical Neurophysiologists.