

HONG KONG SOCIETY OF CRITICAL CARE MEDICINE Ltd.

# GUIDELINES ON CERTIFICATION OF DEATH FOLLOWING THE IRREVERSIBLE CESSATION OF BRAINSTEM FUNCTION

## INTRODUCTION

The irreversible cessation of brainstem function (“brainstem death”) is established by the documentation of irreversible coma and irreversible loss of brain stem reflex responses and respiratory center function or by the demonstration of the cessation of intracranial blood flow. Despite philosophical arguments, the concept that brainstem death is equivalent to death is accepted legally and within the medical community in Hong Kong. Once brainstem death has occurred, artificial life support is inappropriate and should be withdrawn. It is good medical practice to recognize when brainstem death has occurred and to act accordingly, sparing relatives from further emotional trauma of futility.

The purposes of this document are:

1. To provide recommendations for qualified medical practitioners (*vide infra*) in relation to certification of death following the irreversible cessation of brainstem function for patients who are 2 year of age or older; and
2. To provide a reference for the Hong Kong community to reassure them that certification of death following the irreversible cessation of brainstem function is performed with diligence and in accordance with prevailing medical evidence and opinion.

The diagnostic criteria presented for certification of death following the irreversible cessation of brainstem function are based on the following documents:

The Statement issued by the Honorary Secretary of the Conference of Medical Royal Colleges and their Faculties in the United Kingdom on 11 October 1976  
British Medical Journal 1976; ii:1187-1188.

Criteria for the diagnosis of brain stem death. Review by a working group convened by the Royal College of Physicians and endorsed by the Conference of Medical Royal Colleges and their Faculties in the United Kingdom.  
Journal of the Royal College of Physicians of London 1995; 29:381-2

A Code of Practice for the Diagnosis and Confirmation of Death.  
Academy of the Medical Royal Colleges, London, 2008.  
Available from [www.aomrc.org.uk/reports.aspx](http://www.aomrc.org.uk/reports.aspx)

The ANZICS Statement on Death and Organ Donation. Edition 3.2.  
Australian and New Zealand Intensive Care Society, Melbourne, 2013.

Target Temperature Management after out-of-hospital cardiac arrest--a randomized, parallel-group, assessor-blinded clinical trial--rationale and design.  
Nielsen N, Wetterslev J, al-Subaie N. Am Heart J. 2012 Apr;163(4):541-8.

A structured approach to neurologic prognostication in clinical cardiac arrest trials. Cronberg T, Horn J, Kuiper MA, Friberg H, Nielsen N. Scand J Trauma Resusc Emerg Med. 2013 Jun 10;21:45. doi: 10.1186/1757-7241-21-45

They are accepted as being sufficient to distinguish between those patients who retain the functional capacity to have a chance of even partial recovery from those in whom no such possibility exists.

## DIAGNOSTIC CRITERIA

Preconditions and exclusions prior to considering certification of death following the irreversible cessation of brainstem function

1. Diagnosis of severe brain injury which is consistent with progression to brain death (the clinical diagnosis is usually confirmed by neuro-imaging)  
There should be no doubt that the patient's condition is due to irremediable structural brain damage. The diagnosis of a disorder which can lead to brainstem death should have been fully established.

- 1.1 It may be obvious within hours of a primary intracranial event such as severe head injury, spontaneous intracranial haemorrhage, or after neurosurgery that the condition is irremediable.
- 1.2 But when a patient has suffered primarily from cardiac arrest, hypoxia, or severe circulatory insufficiency with an indefinite period of cerebral anoxia or is suspected of having cerebral air or fat embolism then it may take longer to establish the diagnosis.
2. Apnoeic patient on a ventilator  
The patient is unresponsive and not breathing spontaneously. Muscle relaxants (neuromuscular blocking agents) and other drugs should have been excluded as a cause of such findings (*vide infra*).
3. Exclusion of potentially reversible causes of coma
  - 3.1 Depressant drugs or poisons  
Clinical effects of sedative drugs and/or muscle relaxants must be excluded before confirmation of brainstem death.
    - 3.1.1 It is recommended that the drug history should be carefully reviewed and adequate intervals allowed for the persistence of drug effects to be excluded. This is of particular importance in patients whose primary cause of coma lies in the toxic effects of drugs followed by anoxic cerebral damage. The period of observation depends on the pharmacokinetics of the sedative drugs used, the doses used, and the liver and renal function of the patient.
    - 3.1.2 Blood and urine screening tests and measurement of serum levels should be used when necessary.
    - 3.1.3 If there is any doubt about the persisting effects of opioid or benzodiazepines, an appropriate drug antagonist should be given.
    - 3.1.4 A peripheral nerve stimulator should always be used to confirm intact neuromuscular conduction.
  - 3.2 Primary hypothermia  
The body temperature in these patients may be low because of depression of central temperature regulation by drugs or by brain stem damage and it is recommended that it should be greater than 35°C before diagnostic tests are carried out. A low-reading thermometer should be used.

3.3 Metabolic and endocrine disturbances (e.g. severe electrolyte or endocrine disturbances)

Metabolic and endocrine factors contributing to the persistence of coma must be carefully assessed. There should be no profound abnormality of the serum electrolytes, acid base balance, or blood glucose concentrations.

3.4 Arterial hypotension

#### CLINICAL TESTS OF BRAIN STEM FUNCTION

All brain stem reflexes must be absent. The testing of all the following is considered sufficient

1. Both pupils are fixed,  $\geq 4$ mm in diameter and do not respond to changes in the intensity of light.
2. Corneal reflex is absent in both eyes.
3. The vestibulo-ocular reflex is absent.
  - 3.1 Elevate the head to  $30^\circ$  to place the horizontal semicircular canal in a horizontal position.
  - 3.2 This is absent when no eye movement occurs in both eyes during or after the slow injection of at least 50ml of ice-cold water into at least one external auditory meatus, or preferably into each external auditory meatus in turn. Hold eyelids open and observe for eye movement for a minimum of 60 seconds.
  - 3.3 Clear access to the tympanic membrane should be established by direct inspection. This test may be contraindicated on one or other side by local trauma.
4. In case 1, 2, 3 testing of these reflexes are prevented on one or other side by local injury or disease, this does not invalidate the diagnosis of death as a result of cessation of brain-stem reflex. In the case of bilateral injury or disease, confirmatory test should be considered.
5. No motor responses within the trigeminal nerve distribution can be elicited by adequate painful stimulation of any somatic area.

6. There is no gag reflex.
7. There is no cough reflex.
8. Apnoea test should be done last. No respiratory movements occur when the patient is disconnected from the mechanical ventilator for long enough to ensure that the arterial carbon dioxide tension rises above the threshold for stimulating respiration.
  - 8.1 The PaCO<sub>2</sub> must be greater than 8.0kPa and arterial pH less than 7.30. Blood-gas analysis must be available for this test to be performed. If the test is not available the patient must be moved to a facility where this test is routinely available. In patients with pre-existing hypercapnia, it is recommended to wait for a PaCO<sub>2</sub> rise of > 2.7 KPa (20 mmHg) above the chronic level, with a pH<7.30
  - 8.2 These patients may be moderately hypothermic (35°C-37°C), flaccid, and with a depressed metabolic rate, so that PaCO<sub>2</sub> rises only slowly in apnoea (about 0.27kPa/min). They should be disconnected from the mechanical ventilator when their PaCO<sub>2</sub> is close to normal.
  - 8.3 Hypoxaemia during disconnection should be prevented by preoxygenation and administration of oxygen during the test, e.g. by delivering oxygen through a catheter into the trachea.

#### OTHER IMPORTANT CONSIDERATIONS

1. Period of observation and repetition of tests

Clinical confirmation of the diagnosis of brainstem death requires that irreversibility of cessation of brainstem function is established after a period of observation. Two separate examinations should be performed by two medical practitioners.

  - 1.1 The first formal examination should only be performed after
    - 1.1.1 All preconditions have been met
    - 1.1.2 A minimum of four hours observation during which the patient has been comatose (Glasgow Coma Score 3, with painful stimulus applied to areas supplied by the trigeminal nerve), had non-reacting pupils, absent cough and gag reflexes, and no spontaneous breathing efforts.

- 1.2 The second examination can be performed any time after the first examination, so that the total period of observation is a minimum of four hours. The minimum period of observation need to be extended to a total of 24 hours after cardiorespiratory arrest. (See item 1.2 in the section on Preconditions and exclusions prior to considering diagnosis of brainstem death.)
  - 1.3 Therapeutic hypothermia may modify outcome prediction after cardiac arrest and there are published case reports suggesting that determination of brain death might be confounded either by hypothermia itself or by impaired clearance of associated medications. It is therefore recommended, when induced hypothermia has been used after resuscitation from cardiorespiratory arrest, that clinical testing for brain death be delayed for at least 72 hours after rewarming. Brain death may be determined prior to 72 hours by demonstration of absent cerebral blood flow
2. The following observations are compatible with the diagnosis of brainstem death
    - 2.1 Movements of limbs in response to a stimulus outside the distribution of cranial nerves.
    - 2.2 Sweating, blushing, tachycardia.
    - 2.3 Normal blood pressure without pharmacological support.
    - 2.4 Absence of diabetes insipidus (normal osmolar control mechanism)
    - 2.5 Deep tendon reflexes.
    - 2.6 Extensor plantar reflex.
3. The following observations are incompatible with the diagnosis of brainstem death
    - 3.1 Decerebrate or decorticate posturing
    - 3.2 Seizures
4. Confirmatory investigations

If the preconditions for clinical diagnosis and confirmation of brainstem death cannot be satisfied, objective demonstration of absence of intracranial blood flow is required.

- 4.1 Such situations will include:
  - 4.1.1 No clear cause of coma
  - 4.1.2 Possible metabolic or drug effect
  - 4.1.3 Cranial nerves cannot be adequately tested
  - 4.1.4 Cervical vertebral or cord injury
  - 4.1.5 Cardiovascular instability precluding apnoea test
  - 4.1.6 Severe hypoxaemic respiratory failure precluding apnoea test
- 4.2 Confirmatory investigations which may be used include:
  - 4.2.1 Four vessel radio-contrast angiography by digital subtraction, may be used to demonstrate absent intracranial blood flow. Blood flow should be absent from both vertebro-basilar and supratentorial circulation
  - 4.2.2 Radionuclide examination which reliably demonstrates absent brain perfusion can also be used for this purpose. A radiopharmaceutical which can cross the blood-brain barrier and be retained by brain parenchyma, either technetium-99m hexamethylpropylene amine oxime (<sup>99m</sup>Tc-HMPAO) or technetium-99m ethyl cysteinate dimer (<sup>99m</sup>Tc-ECD), should be used. The technique of single-photon emission computed tomography (SPECT) is employed in determining the perfusion of brain stem, cerebrum and cerebellum.
- 4.3 The four hour period of observation of coma and of absent brain stem responses, where these can be tested, should also apply and should precede the investigation.
- 4.4 Written certification of brain death should be made by the two medical practitioners (not including the medical practitioner who performed the investigation) who, having performed the clinical test of brain stem function and with the knowledge of the circumstances of the aetiology of the coma, are further assisted in making the diagnosis of brain death by evidence of absent intracranial blood flow. At least one set of clinical test should be performed before the confirmatory test. If there is any brain stem response elicited in the clinical test, confirmatory investigation should not be proceeded

5. Time of death

- 5.1 The time of death should be recorded as the time when certification of brain death has been completed, that is, following the second clinical examination of brain stem function.
- 5.2 If a confirmatory investigation is used, then the time of death should be made by clinician who performed the second set of clinical test after the confirmatory investigation of absent intracranial blood flow. If two sets of clinical tests were performed before the confirmatory test, then either one of the clinicians who perform the clinical test need to check and interpret the imaging result and to complete the certification process if appropriate.

GENERAL RECOMMENDATIONS

It is recommended that hospitals establish a policy and set of procedures incorporating these guidelines that will govern the confirmation of brain death. These would include:

1. A description of the procedures for certification of death following irreversible cessation of brainstem function within the hospital including:
  - 1.1 Certification of brainstem death based upon this document;
  - 1.2 The duties and responsibilities of designated officers;
  - 1.3 The location of all necessary documents;
  - 1.4 The location of contact numbers for police, forensic pathologists and coroner;
  - 1.5 Details of support services available to staff and families.
2. Recommendations for the status of the two medical practitioners certifying death following irreversible cessation of brainstem function and a registry of suitably qualified practitioners accredited to perform such procedures in the hospital.
  - 2.1 One of the medical practitioners must be a specialist recognized and designated by the appropriate College as having demonstrated skill and knowledge in the certification of death following irreversible cessation of brainstem function. This should usually be an intensivist, critical care physician, neurologist or neurosurgeon.

- 2.2 The other medical practitioner should preferably be of the same qualification as described in 2.1 but should be at least 6 years after registration and possess the skill and knowledge in the certification of death following irreversible cessation of brainstem function.
- 2.3 The person authorizing removal of tissues and the person removing tissues MUST NOT be responsible for determining brainstem death.
- 2.4 The intensivist caring for an intensive care patient (e.g. with acute liver failure who is listed for urgent transplantation) who is a potential recipient of organs from the potential donor should not discuss donation with the family of the potential donor.
3. A registry of suitably qualified practitioners accredited to perform confirmatory investigations in the hospital. Recommendations of the appropriate College should be followed where applicable.
4. Suitable forms to certify death following irreversible cessation of brainstem function.
5. Access to information about brainstem death and organ donation.  
This information should be suitable for doctors, nurses and allied health practitioners as well as lay people and should be available for the relatives of patients who are confirmed dead following irreversible cessation of brainstem function.

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