DETERMINATION OF BRAIN DEATH

POLICY©

DOCUMENT SUMMARY/KEY POINTS

- Determination of brain death requires understanding of the pathophysiology that leads to cessation of whole brain function.
- Before brain death testing can occur preconditions must be met prior to and during the 4 hours period of observation. During this time the patient must be intubated and ventilated with evidence of unresponsive coma (absence of brain-stem reflexes and respiratory centre function that is irreversible).
- In the case of a term neonate (≥36 weeks gestation and ≤30 days old) the first clinical brain death testing should occur either after 48 hours from birth or 24 hours from insult
- Recommended that in cases of acute hypoxic-ischemic brain injury, clinical brain death testing is delayed for at least 24 hrs after restoration of spontaneous circulation.
- TWO separate tests must be performed by two different medical practitioners. The tests MUST be done separately but can be done consecutively. In the case of a neonate (≥36 week's gestation and ≤30days of age) clinical brain death tests should be 24 hours apart.
- The time of death should be documented at the time of completion of the second clinical test.
- A patient must meet the preconditions prior to Brain Death testing.
- ALL components of the clinical test must be performed to determine the diagnosis of brain death. If the patient cannot complete all aspects of the test then imaging that demonstrates the absence of intracranial blood flow to the brain is to be considered.
- The clinical test is comprised of three main components
  - COMA
  - ABSENT Brain Stem Reflexes
  - APNOEA

Approved by:	SCHN Policy, Procedure and Guideline Committee	
Date Effective:	1st March 2018	**Review Period**: 3 years
Team Leader:	Staff Specialist Organ & Tissue Donation Service	**Area/Dept**: Intensive Care Unit, CHW

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CHANGE SUMMARY

- Updated the document based on the ANZICS "Statement on Death and Organ Donation 3.2" 2013. The amendments are to the following topics:
    - Observation period prior to testing
    - Effect of therapeutic hypothermia on brain death testing
- Amend flow chart – Appendix 1
- Updated references

READ ACKNOWLEDGEMENT

- ALL medical practitioners that perform clinical test for the diagnosis of brain death should read and acknowledge this document
- Training/Assessment Required – for registrars/fellows in PICU
- Nursing staff looking after potential brain dead patients should read this document.

TABLE OF CONTENTS

1. Policy Statement

In cases where organs/tissues are to be retrieved for the purpose of transplantation, cessation of brain function need to be certified according to ANZICS recommendations.

The following information is based on the document: "The ANZICS statement on Death and Organ Donation – Edition 3.2; 2013, Australian & New Zealand Intensive Care Society".

A copy of the document is available at the following website:
http://www.anzics.com.au/death-and-organ-donation

The above mentioned statement reviews evidence from:

- the UK "the criteria for determination of brain death, outlined in the joint statement of the Medical Royal Colleges and their Faculties of the United Kingdom"
- the USA "the criteria for determination of brain death in the Report of the Medical Consultants on the Diagnosis of Death to the President's Commission"
- peer reviewed published literature on brain death determination and intracranial blood flow

2. Legal definition of death

Death is legally said to occur when there is irreversible cessation of circulation of blood in the body of a person, or irreversible cessation of all function of the brain of the person.

The term "brain death" should be used when death is certified using the brain function criteria.

Determination of brain death requires:

- understanding of the pathology that lead to cessation of **whole** brain function.
- Cessation of **whole** brain function, as determined by clinical testing if preconditions are met or imaging that demonstrates the absence of intracranial blood flow:

3. Clinical Determination of brain death

Once Brain death has been determined- the person has died.

Testing is carried out to diagnose brain death in order to determine death in the presence of a beating heart. This confirms for staff and families that death has occurred and that continuation of treatment serves no purpose for the child. Brain death testing should be performed irrespective of the donor status of the child.

Formal clinical brain death testing is a legal requirement in order to retrieve organs, from a deceased person with a beating heart, for the purpose of transplantation.

3.1 Preconditions prior to formal brain stem function testing

The following conditions must be met before clinical brain death testing may be performed. If any of the following are not met then clinical brain death testing cannot proceed until **all** the preconditions are met.

- **Normothermia** – core temperature >35°C.
- **Normotension** – age appropriate mean blood pressure.
- **Exclusion of effects by sedative drugs** – care must be taken when considering the continued effects of sedative drugs and in particular the decreased metabolic clearance rate of the drugs when therapeutic hypothermia (post-cardiac arrest) has been used. In the case of barbiturates, either levels should be shown to be below clinically significant levels (<10mg/L) or brain death should be demonstrated by absence of cerebral blood flow. If there are concerns about the persistent effects of benzodiazepines or opiates the appropriate reversal agent should be administered.
- **Absence of electrolyte, metabolic or endocrine disturbances**
- **Intact neuromuscular function** – if neuromuscular blocking agents have been administered as part of the treatment management of the patient, then peripheral nerve stimulator should be used to confirm normal neuromuscular conduction.
- **Ability to examine brain stem reflexes** – ability to examine at least one eye and one ear. Care must be taken to ensure that NO dilating eye drops have been used. If they have, then then a period of at least 24 hours should elapse or consultation with ophthalmology should occur to meet preconditions.
- **Ability to perform apnoea test** – may not be able to perform if the patient also has severe hypoxemic respiratory or high cervical spinal cord injury

3.2 Clinical Testing of Brain Stem Function

This is divided into two sections: (1) Observation period and (2) Formal examination.

Observation period

The patient must have met the preconditions stated above, before the **4 hour** period of observation can commence. The preconditions must be met during the entire observation period. This observation period must occur before brain death testing can be performed. During this time the patient must be intubated and ventilated with:

- No spontaneous breathing efforts
- Pupils non- reactive to light (fix and dilated).
- Absent cough and gag reflexes.

In the event of a **cardiorespiratory arrest** with unknown cause, the observation period should be delayed by **24 hours** from return of spontaneous circulation.

In an infant >30 days of age the above criteria for determination of brain death may be applied. In the case of a term neonate (≥36 weeks gestation and ≤30 days old) the first clinical test should occur either after 48 hours from birth or 24 hours from insult and the first clinical test must be separated from the second clinical test by a minimum of 24 hours. If

infant < 36 weeks gestation clinical brain death testing is not indicated, imaging to demonstrate the absence of intracranial blood flow is needed to determine brain death

If therapeutic hypothermia is used post-resuscitation following cardiorespiratory arrest, brain death testing should be delayed by 24 hours AFTER rewarming. However, brain death may be confirmed prior to 24 hours by demonstration of absent cerebral blood flow.

Formal examination

Two medical partitioners perform the clinical examinations for determination of brain death. The two tests must be performed separately but may be done consecutively, except for the case of term neonates (as described above).

NSW legislation mandates that each practitioner:

- *Have practiced medicine for not less than 5 years in the preceding 8 years*
- *1 practitioner MUST be a designated specialist for the hospital*
- *MUST NOT be the designated officer*
- *MUST NOT be involved in organ/ tissue retrieval*
- *SHOULD NOT be responsible for care of the intended recipient*

All of the components of the clinical test must be performed to determine brain death. The clinical test **must confirm all** of the following:

- Coma
- Absence of brain-stem reflexes
- Apnoea

Time of death is recorded as the time when certification of brain death is completed, i.e. following the second examination or following demonstration of absent cerebral blood flow.

The clinical test is comprised of the following components:

1. **Coma**
    i. **Test:** Apply noxious stimulus to the cranial nerve distribution, sternum and all four limbs (e.g. deep nail bed pressure).
    ii. **Response:** No flexor or extensor motor response. Glasgow coma Scale (GCS) 3. Spinal reflexes may be elicited with painful stimulus.
    iii. **NOT able to determine brain death if:** True extensor or flexor motor response demonstrated on stimulation ➔ STOP clinical testing
2. **Brain stem reflexes (ALL MUST be absent to determine brain death)**
    - *Pupillary reaction to light (CN II and III)*
        i. **Test:** Shine bright light into the eye and look for pupillary constriction, Pupils must be ≥ 4mm in size.
        ii. **Response:** No pupillary constriction.

iii. **NOT able to determine brain death if:** Pupils constrict ➔ STOP clinical testing.

- *Corneal reflexes (CN V and VII))*
  i. **Test:** Touch the corneas with a soft cotton wool or gauze. Ensure to be gentle as corneas may damage easily.
  ii. **Response:** No blink reflex.
  iii. **NOT able to determine brain death if:** blink reflex is observed ➔ STOP clinical testing.
- *Pain reflex (V and VII)*
  i. **Test:** Apply pain over trigeminal nerve distribution (e.g. supraorbital ridge).
  ii. **Response:** No facial or limb response.
  iii. **NOT able to determine brain death if:** Movement of face or limbs ➔ STOP clinical testing.
- *Vestibulo-ocular reflexes (CN II, IV, VI, VIII)*
  i. **Test:** Use an otoscope to visualize the ear drum (ruptured ear drum does not preclude the test but wax must be removed before the test may proceed). Head must be at 30° and 50ml of ice cold water should be instilled into the ear canal using a syringe. Eye lids must be held open to observe eye movement for a minimum of 60 seconds.
  ii. **Response:** No eye movement.
  iii. **NOT able to determine brain death if:** ANY eye movement ➔ STOP clinical testing
- *Gag reflex (CN IX and X)*
  i. **Test:** Stimulate both sides of posterior pharyngeal wall with a cotton swab or tongue depressor.
  ii. **Response:** No gag.
  iii. **NOT able to determine brain death if:** Gag present ➔ STOP clinical testing.
- *Cough reflex (CN X)*
  i. **Test:** Stimulate the tracheal wall with a soft suction catheter.
  ii. **Response:** No cough.
  iii. **NOT able to determine brain death if:** Cough present ➔ STOP clinical testing.

3. **APNOEA** – *Proceed ONLY if all of the above reflexes are ABSENT*. The apnoea test is performed as the final clinical test to determine brain death

   i. **Test:** Pre-oxygenate with 100% oxygen for minimum of 5 minutes. Arterial blood gas should be collected prior to the start of the test. The patient should be disconnected for the mechanical ventilator but oxygen can be administered via a catheter inserted into the endotracheal tube (oxygen flow 1-2 L/min). Continuous Positive Airway Pressure (CPAP) may be administered throughout the apnoea test to avoid hypoxia (turn OFF apnoea ventilation mode). An arterial blood gas should be collected at the end of the test. The arterial pCO_2 should be >60 mmHg and arterial pH should be <7.30 (with oxygenation throughout the test) to

provide adequate stimulus to spontaneous ventilation and in the case of chronic hypercarbia the pCO_2 should have risen by 20 mmHg from baseline and a pH <7.30.

ii. **Response:** No spontaneous breaths.

iii. **NOT able to determine brain death if:** Spontaneous breathing ➔ STOP clinical testing.

3.3 Observations compatible/incompatible with the diagnosis of brain death

Observations Compatible with the diagnosis of brain death:

- **Spinal reflexes**
  - Lazarus sign
  - Deep tendon reflexes
  - Undulating toe reflex (plantar flexor or extensor response)
  - Respiratory – like movement with no significant tidal volumes
  - Head turning
- **Sweating, blushing, tachycardia**
- **Normal blood pressure** – absence of the need for inotropes
- **Absence of diabetes insipidus (DI)**

Observation Incompatible with the diagnosis of brain death:

- Decerebrate or decorticate posturing
- True extensor or flexor motor response to painful stimulus
- Seizures

4. Imaging to Assess Intracranial Blood Flow

In cases where clinical criteria for brain death testing cannot be met, imaging can be used to determine brain death.

For example:

- Cardiovascular instability or severe hypoxic respiratory failure precluding the apnoea test.
- Cranial nerves cannot be adequately tested.
- Concern that medications or metabolic state may effect clinical brain death testing

In such cases, two medical practitioners, having examined the patient and in the knowledge of the circumstances of the onset of coma, are further assisted in making the diagnosis of brain death by evidence of absent intracranial blood flow. The imaging should ONLY be performed once adequate blood pressure is achieved (with or without the use of inotropes).

The time of death should be recorded as the time the second clinician confirms absence of intracranial blood flow.

If aspects of the testing cannot be completed, due to trauma or existing pathology, then documentation should include: the fact that preconditions were met and detail the components of clinical brain death testing that were completed. Documentation should occur prior to proceeding to imaging.

Four vessel intra-arterial catheter angiography is considered to be the gold standard to demonstrate the absence of blood flow to the brain parenchyma. The contrast medium is injected directly into both carotid and vertebral arteries.

A **radionuclide scan** can also be used as an objective confirmation of brain death, in cases where clinical criteria cannot be met, by demonstrating absence of perfusion. It is important to remember that the radio-nucleotide used needs to cross the blood-brain barrier.

Contrast CT or CT angiography is another mode of imagining that has been used. There are no large studies that have demonstrated the specificity and sensitivity of this mode of study. There have not been any reported cases of absent blood flow as detected by CT angiography that were NOT declared brain dead via clinical test or four vessel catheter angiography. Larger studies with matched controls are needed.

MRI has been used to demonstrate the absence of flow into the brain parenchyma. Caution must be used when interpreting these scans as in some cases slow flow may mimic absence of flow. These false positive results depend on a large number of variables, consequently the *ANZICS statement on brain death does not recommend the use of MRI to determine absence of blood flow to the brain.*

Transcranial Doppler (TCD) is an imaging technique that can be used as a screening tool to optimise timing of a contrast study but should not be used to determine absence of blood flow to the brain.

ANZICS recommendation: Four-vessel angiography and radionuclide imaging are preferred imaging to assess intracranial blood flow. MRI and TCD are NOT recommended.

5. Documentation

Accurate documentation is paramount and all preconditions and components of the test need to be documented. This is a requirement recommended by the Australian law reform Commission.

To aid in this process of documentation the NSW Health PD2013-001 (page 27) has developed a “Certification of brain death” form. This form is available in the intensive care units across the network (Appendix 2) otherwise please contact the OTDS staff form more information.

6. Glossary

Brain death

Death defined by irreversible cessation of all function of the person's brain

Designated Officer (DO)

The role of the Designated Officer is to authorise:

1. the removal of tissue from a body for transplant or other therapeutic, medical or scientific purposes;
2. the performance of non-coronial post mortem examination;
3. the release of a body for anatomical examination

The Designated Officer has discretionary authority not simply administrative authority. The role may require decision-making, conflict resolution, and high level communication and negotiation skills.

The Public Health Organisation Board of Governing Authority must appoint a Designated Officer in any hospital where post mortems, donation of tissue etc. are carried out.

The appointment of several Designated Officers may be necessary to ensure that one is available when required, particularly after hours.

Source: NSW Human Tissue Act 1983 No.164 (includes amendments up to Act 2003 No. 45 and NSW Health Circular 2004/1).

Intensive Care Unit (ICU)

Includes Paediatric Intensive Care Unit (PICU) and Neonatal Intensive Care Units (NICU)

Intensivist

Refers to Paediatric Intensive Care physicians

7. References and Further Reading

1. The ANZICS Statement on Death & Organ Donation (Edit 3.2 2013) Australian & New Zealand Intensive Care Society. Melbourne. ISBN 1 876980 21 4
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4. Settergren, G. 'Brain death: an important paradigm shift in the 20th century', *Acta Anaesthesiol Scand* 2003; 47(9):1053-58.
5. 'Guidelines for the determination of death. Report of the medical consultants on the diagnosis of death to the President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research', *JAMA* 1981; 246(19); 2184-86.
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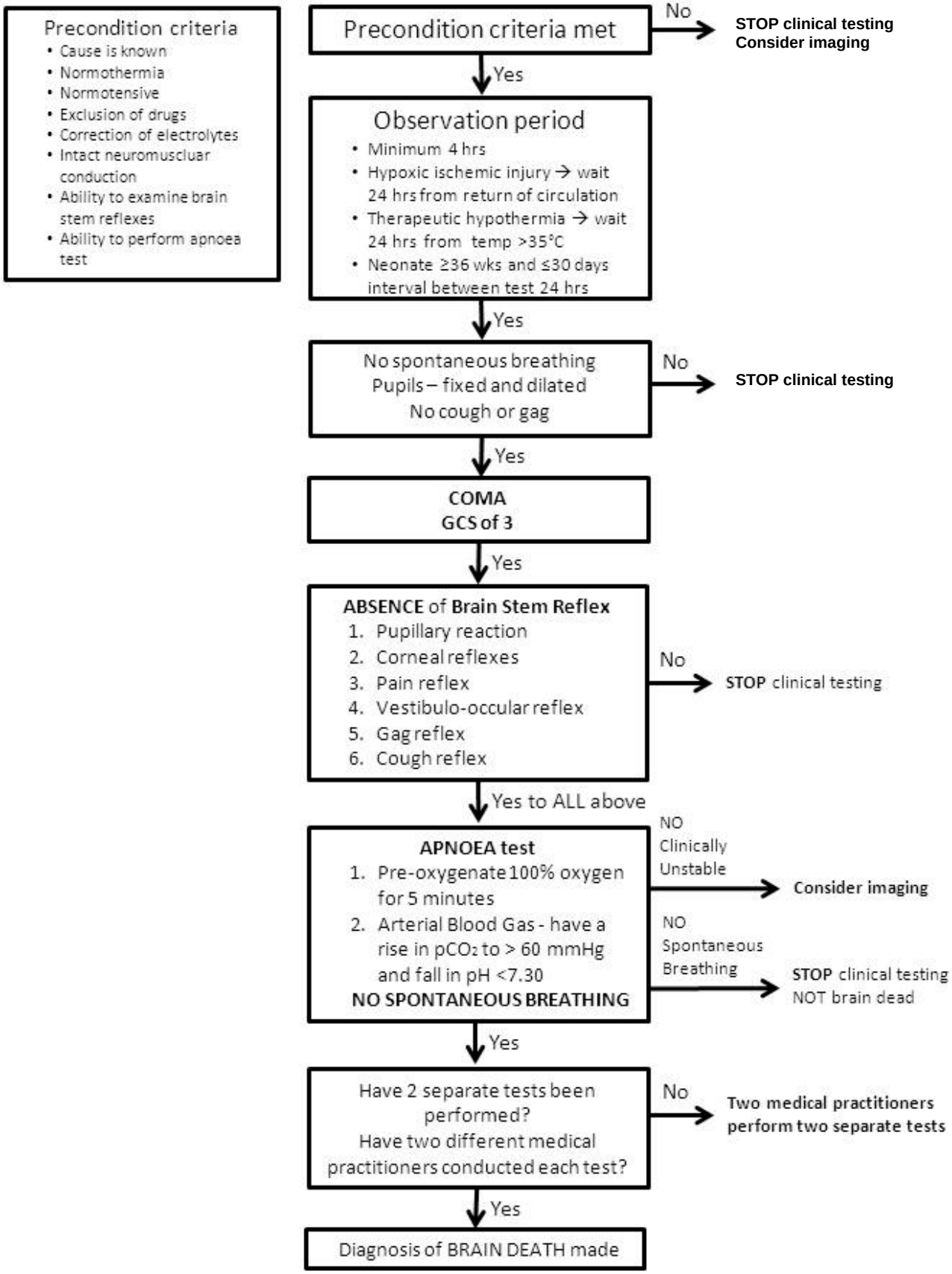
8. Wijdicks, E.F.'Brain death worldwide: accepted fact but no global consensus in diagnostic criteria', *Neurology* 2002; 58:20-25.
9. National Health and Medical Research Council (2007) Organ and Tissue Donation after Death for Transplantation: Guidelines for Ethical Practice for Health Professionals. http://www.nhmrc.gov.au/publications/synopses/files/e75.pdf .

10. Australian Transplant Coordinators Association (2008) National Guidelines for Organ and Tissue Donation 4th Edit.
11. SESIAHS Policy on Organ and Tissue Donation after Brain Death (2007)/ Organ Donation (Deceased Infant or Child) 2007.
12. Rosenklint, A 'Evaluation of angiographic methods in the diagnosis of brain death. Correlation with local and systemic arterial pressure and intracranial pressure', Neuroradiology 1971; 7:215-19.

Appendix 1 – Flow chart for Determination of BRAIN DEATH



Appendix 2:– SCHN "certification of brain death" form (example only)

NSW Health

Facility:

SMR010517

CERTIFICATION OF BRAIN DEATH

FAMILY NAME | MRN

GIVEN NAME | ☐ MALE ☐ FEMALE

D.O.B. ____/____/____ | M.O.

ADDRESS

LOCATION / WARD

COMPLETE ALL DETAILS OR AFFIX PATIENT LABEL HERE

For the purposes of the law of NSW, a person has died when there has occurred: (a) irreversible cessation of all function of the person's brain. (s 33 Human Tissue Act 1983) A designated officer shall not give an authority to remove tissue from a deceased person for it's use for transplantation unless each of 2 medical practitioners has certified in writing that the following has occurred.

Known cause of irreversible loss of brain function

There is acute brain pathology consistent with the irreversible loss of brain function

Doctor A: *Specify condition* _____

Doctor B: *Specify condition* _____

Period of continuous observation of apparent loss of neurological function

There has been at least a 4 hour period of observation (24 hours for hypoxic-ischaemic encephalopathy) and mechanical ventilation during which the patient has unresponsive coma, with pupils nonreactive to light, absent cough/tracheal reflex and no spontaneous breathing efforts.

This period began at (Date and time) _____

Determination of brain death by clinical examination * Preconditions	Doctor A Please √	Doctor B Please √
1. Hypothermia is not present – temperature is > 35°C Specify Temperature:	_____°C	_____°C
2. Blood pressure is adequate (eg MAP>60 in an adult)	☐	☐
3. Sedative drug effects are excluded	☐	☐
4. There is no severe electrolyte, metabolic or endocrine disturbance	☐	☐
5. Neuromuscular function is intact	☐	☐
6. It is possible to examine the brain-stem reflexes (including at least one ear and one eye)	☐	☐
7. It is possible to perform apnoea testing	☐	☐
Clinical Testing		
1. There is no motor response in the cranial nerve distribution to noxious stimulation of the face, trunk and four limbs and there is no response in the trunk or limbs to noxious stimulation within the cranial nerve distribution	☐	☐
2. There are no pupillary responses to light	☐	☐
3. There are no corneal reflexes	☐	☐
4. There is no gag (pharyngeal) reflex	☐	☐
5. There is no cough (tracheal) reflex	☐	☐
6. There are no vestibulo-ocular reflexes on ice-cold caloric testing	☐	☐
7. Breathing is absent (despite arterial pCO_2 > 60mmHg (8pKa) and arterial pH < 7.30)	pCO_2 _____	pCO_2 _____
8. Specify pCO_2 in **mmHg** or **kPa** (*circle one*) and pH at end of apnoea	pH _____	pH _____

Determination of brain death when clinical examination cannot be done:	Doctor A Please √	Doctor B Please √
1. There is no intracranial blood flow	☐	☐
2. *(Delete one as appropriate)* This has been demonstrated by *either* **intra-arterial angiography** *or* **other suitably reliable method**		
Other (Specify) _____		

We have determined, according to the above procedures, that irreversible cessation of all function of the person's brain has occurred

Doctor A (Name): _____	Doctor B (Name): _____
Designation: _____	Designation: _____
Signature: _____	Signature: _____
Date and time of assessment: _____	Date and time of assessment: _____

Date and time of death (End of the assessment by second doctor): _____

*Based on criteria developed by the Australian New Zealand Intensive Care Society, the ANZICS statement on Death and Organ Donation, edition 3.1, 2010

Example only

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CERTIFICATION OF BRAIN DEATH

SMR010.517

N#690617 050213

NO WRITING

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