Form for the Diagnosis of Death using Neurological Criteria {long version}

This form is consistent with and should be used in conjunction with, the AoMRC (2008) *A Code of Practice for the Diagnosis and Confirmation of Death* and has been endorsed for use by the following institutions: Intensive Care Society and the Faculty of Intensive Care Medicine.

HOSPITAL ADDRESSOGRAPH or

Surname
First Name
Date of Birth
NHS / CHI Number

Objective of Care

- To diagnose and confirm the death of a mechanically ventilated, severely brain injured patient in coma, using neurological criteria.

Academy of the Medical Royal Colleges Definition of Human Death (2008).[1]

"Death entails the irreversible loss of those essential characteristics which are necessary to the existence of a living human person and, thus, the definition of death should be regarded as the irreversible loss of the capacity for consciousness, combined with irreversible loss of the capacity to breathe. The irreversible cessation of brain-stem function whether induced by intra-cranial events or the result of extra-cranial phenomena, such as hypoxia, will produce this clinical state and therefore irreversible cessation of the integrative function of the brain-stem equates with the death of the individual and allows the medical practitioner to diagnose death."

Context

- National professional guidance advocates the confirmation of death using neurological criteria wherever this seems a likely diagnosis and regardless of the likelihood of organ donation.[2]
- UK General Medical Council (GMC) guidance on end of life care (2010) states that national procedures for identifying potential organ donors should be followed and, in appropriate cases, the specialist nurse for organ donation (SN-OD) should be notified.[3] NICE guidance recommends that the specialist nurse for organ donation (SN-OD) should be notified at the point when the clinical team declare the intention to perform brain-stem death tests.[4]

  Date and time of referral to SN-OD:

- Whilst most patients will already be in an Intensive Care Unit (ICU) when the diagnosis is suspected, some patients may be in other areas, e.g. the Emergency Department. On such occasions it is legitimate, if considered necessary, to transfer a patient to the ICU for the diagnosis to be made.

- For many clinicians the diagnosis and confirmation of death using neurological criteria, will be a relatively infrequent task and may be complicated by uncertainties regarding the nature of the primary diagnosis, irreversibility and the availability of suitably experienced personnel. Updated guidance on the diagnosis and confirmation of death by neurological criteria was published by the Academy of the Medical Royal Colleges in 2008.[1] A series of helpful education videos are available https://www.odt.nhs.uk/deceased-donation/best-practice-guidance/donation-after-brainstem-death/diagnosing-death-using-neurological-criteria/.

The Patient's Close Family and Friends

Should be made aware that the purpose of testing is to confirm if the patient's death has already occurred. If given an opportunity to witness the neurological examination, they should be prepared for the possibility of spinal reflexes and their relevance, as far as the diagnosis of death by neurological criteria is concerned. Whether the patient's close family and friends witness the clinical examination or not, the patient's need for dignity, privacy and spiritual support, remain paramount.

Form for the Diagnosis of Death using Neurological Criteria {long version}

Patient Name: **NHS / CHI Number:**

Preparation

1. Evidence for Irreversible Brain Damage of known Aetiology

Case records, past medical history including possibly contacting the GP, relevant imaging.

2. Exclusion of Reversible Causes of Coma and Apnoea

Standard ICU cardio-respiratory monitoring (to ensure haemodynamic stability), medication chart and history, blood and urine drug assay results (where relevant), drug antagonists (e.g. flumazenil, naloxone), peripheral nerve stimulator, recent serum glucose and biochemistry, thermometer, patient warming device.

3. Tests for Absence of Brain-Stem Function

Brain-stem reflexes

Bright light source; small gauze sterile swabs, otoscope with disposable ear pieces, 50 ml luer lock syringe and disposable quill, ice-cold water; a spatula, Yankauer sucker or laryngoscope, endotracheal suction catheters.

Apnoea test

Haemodynamic monitoring (continuous ECG, invasive arterial pressure), arterial blood gas analysis including blood gas syringes x4, pulse oximetry and end-tidal CO_2 monitoring, means of delivering oxygen to the trachea by bulk flow (e.g. Mapleson C circuit which allows CPAP or endotracheal suction catheter and oxygen tubing).

Diagnostic caution is advised in the following 'Red Flag' patient groups. (Based on the literature and unpublished case reports.) For advice in difficult circumstances contact the local or regional Clinical Lead for Organ Donation or the regional neuro-intensive care unit.

1. Testing **< 6 hours** of the loss of the last brain-stem reflex
2. Testing < 24 hours of the loss of the last brain-stem reflex, where aetiology primarily anoxic damage
3. **Hypothermia** (24 hour observation period following re-warming to normothermia recommended)
4. Patients with **any neuromuscular disorders**
5. **Steroids** given in space occupying lesions such as abscesses
6. Prolonged **fentanyl** infusions
7. Aetiology **primarily** located to the **brain-stem or posterior fossa**

Examining Doctors

Date and time:

Patient Location:

Doctor One, Name and Designation
Name:

Grade:

Doctor Two, Name and Designation
Name:

Grade:

Guidance

1. The diagnosis of death by neurological criteria should be made by at least two medical practitioners. Both medical practitioners should have been registered with the General Medical Council (or equivalent Professional Body) for more than five years and be competent in the assessment of a patient who may be deceased following the irreversible cessation of brain-stem function and competent in the conduct and interpretation of the brain-stem examination. At least one of the doctors must be a consultant. See below for special guidance in children.
2. Those carrying out the tests must not have, or be perceived to have, any clinical conflict of interest and neither doctor should be a member of the transplant team. Clinical Leads for Organ Donation can carry out testing and are likely to have significant expertise.
3. Testing should be undertaken by the nominated doctors acting together and must always be performed on two occasions. A complete set of tests should be performed on each occasion, i.e., a total of two sets of tests will be performed. Doctor One may perform the tests while Doctor Two observes; this would constitute the first set. Roles may be reversed for the second set. The tests, in particular the apnoea test, are therefore performed only twice in total.

Form for the Diagnosis of Death using Neurological Criteria {long version}

Patient Name: **NHS / CHI Number:**

Evidence for Irreversible Brain Damage of known Aetiology

Primary Diagnosis:

Evidence for Irreversible Brain Damage of known Aetiology:

Guidance

1. The patient must have a Glasgow Coma Score of 3 and be mechanically ventilated with apnoea.
2. There should be no doubt that the patient's condition is due to irreversible brain damage of known aetiology.
3. It remains the duty of the two doctors carrying out the testing to be satisfied with the aetiology, the exclusion of all potentially reversible causes, the clinical tests of brain-stem function and of any ancillary investigations; so that each doctor may independently confirm death following irreversible cessation of brain-stem function.
4. Occasionally it may take a period of continued clinical observation and investigation to be confident of the irreversible nature of the brain injury. The timing of the first test and the timing between the two tests should be adequate for the reassurance of all those directly concerned.
5. It is recommended that there is a minimum of twenty-four hours, of continued clinical observation, in patients where anoxic damage, following cardiorespiratory arrest, is the aetiology of the brain injury. If prior treatment of the patient has included induced hypothermia, it is recommended that there is a minimum of twenty-four hours, of continued clinical observation, following re-warming to normothermia. See above for 'Red Flag' patient groups.
6. Stabilisation of the patient prior to testing, especially support of the cardiovascular system, is a prerequisite to testing. Mean Arterial Pressure should be consistently >60mmHg and appropriate fluid resuscitation administered. This almost invariably requires the use of inotropes / vasopressors via central venous access.
7. Diabetes insipidus can develop rapidly and should be suspected in patients with a high urine output (typically greater than 100 mls/hr) and rising Na_+. Matched urinary and plasma electrolytes and osmolality may assist in the diagnosis. Treatment with desmopressin, 1-2 mcg boluses, is usually sufficient for treatment but repeated doses or vasopressin infusion may be required. Serum sodium should ideally be maintained between 140-160mmol/L.

Validity of neurological criteria to diagnose death in children.

- **Older than 2 months:** guidance unchanged. Recommended paediatric form available.
- **Between thirty seven weeks corrected gestation (post menstrual) age to 2 months of age post term**: use the RCPCH Guidance available at www.rcpch.ac.uk. Form available.
- **Infants less than 37 weeks corrected gestation (post menstrual) age:** the concept of brain-stem death is inappropriate for infants in this age group.

In addition to the usual requirement (as given above) that one of the examining doctors is a consultant, additionally in children, one of the doctors should normally be a paediatrician or should have experience with children and one of the doctors should not be primarily involved in the child's care.

Form for the Diagnosis of Death using Neurological Criteria {long version}

Patient Name: **NHS / CHI Number:**

Exclusion of Reversible Causes of Coma and Apnoea

Guidance
Attempts should be made to maintain relatively normal cardiovascular and respiratory physiological parameters in the preceding hours prior to testing.
This may not be possible and does not necessarily preclude testing.

The key question the two doctors must exclude is the possibility that cardiovascular and respiratory instability is the cause of the observed coma and apnoea.
The answer should be no.

	1st Test		2nd Test	
Mean arterial pressure at time of testing? Should be consistently >60mmHg prior to testing.	mmHg		mmHg	
$PaCO_2$ at time of testing? A goal of normocarbia ($PaCO_2$ <6.0 kPa), *if possible*, is recommended in the preceding hours prior to testing. See below for *starting $PaCO_2$ in the apnoea test*.	kPa		kPa	
PaO_2 at time of testing? Hypoxia should be avoided *if possible* (PaO_2 >10 kPa).	kPa		kPa	
Arterial pH/[H^+] at time of testing? Acidaemia and alkalaemia should be avoided, *if possible*, aiming for a relatively normal pH 7.35 –7.45 / [H^+] 45-35 nmols/L.	pH/[H^+]=		pH/[H^+]=	
Is the coma or apnoea due to ongoing cardiorespiratory instability? **(To diagnose death using neurological criteria, ALL answers should be NO)**	**Dr One** **Yes / No**	**Dr Two** **Yes / No**	**Dr One** **Yes / No**	**Dr Two** **Yes / No**

Guidance
The patient should not have received any drugs that might be contributing to the unconsciousness, apnoea and loss of brain-stem reflexes (narcotics, hypnotics, sedatives or tranquillisers); nor should they have any residual effect from any neuromuscular blocking agents (atracurium, vecuronium or suxamethonium).

It remains the duty of the two doctors carrying out the testing to be satisfied that sufficient time has elapsed to ensure that any remaining drug effect is non-contributory to the unconsciousness and loss of brain-stem reflexes. This will be based on an assessment of the medications the patient has received and from knowledge of the pharmacokinetics of these agents. Renal or hepatic failure may prolong metabolism / excretion of these drugs. See above for 'Red Flag' patient groups.

Form for the Diagnosis of Death using Neurological Criteria {long version}

Patient Name: **NHS / CHI Number:**

	1st Test		2nd Test	
Where there is any doubt, specific drug levels should be measured (midazolam should be less than <10mcg/L, thiopentone <5mg/L).	Drug levels (if measured):		Drug levels (if measured):	
Antagonists such as flumazenil, naloxone and neostigmine may be used but there is no specific pharmacological data for predicting the dose effect of these antagonists.	Drug antagonists (if used):		Drug antagonists (if used):	
Residual neuromuscular blockade can be tested for, if felt necessary, by peripheral nerve stimulation.	Train of Four (if measured):		Train of Four (if measured):	
Is the coma or apnoea due to depressant drugs? **(To diagnose death using neurological criteria, ALL answers should be NO)**	**Dr One Yes / No**	**Dr Two Yes / No**	**Dr One Yes / No**	**Dr Two Yes / No**
Body temperature at time of testing? If core temperature is ≤ 34°C testing cannot be carried out.	^{o}C		^{o}C	
Serum sodium (Na^+) at time of testing? Serum sodium should be between 115-160mmol/L. Rapid rises or falls in Na^+ should be avoided.	mmol/L		mmol/L	
Serum potassium (K^+) at time of testing? Serum potassium should be > 2mmol/L.	mmol/L		mmol/L	
Serum phosphate (PO_{43}^-) at time of testing? Serum phosphate should not be profoundly elevated (>3.0mmol/L) or lowered (<0.5mmol/L) from normal.	mmol/L		mmol/L	
Serum magnesium ($Mg2^+$) at time of testing? Serum magnesium should not be profoundly elevated (>3.0mmol/L) or lowered (<0.5mmol/L) from normal.	mmol/L		mmol/L	
Blood glucose at time of testing? Blood glucose should be between 3.0-20.0 mmol/L and should be tested prior to each test.	mmol/L		mmol/L	
If there is any clinical reason to expect endocrine disturbances hormonal assays should be undertaken.	Hormone level (if measured):		Hormone level (if measured):	
Is the coma or apnoea due to a metabolic or endocrine disorder? **(To diagnose death using neurological criteria, ALL answers should be NO)**	**Dr One Yes / No**	**Dr Two Yes / No**	**Dr One Yes / No**	**Dr Two Yes / No**

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{long version}

Patient Name: **NHS / CHI Number:**

Guidance
It remains the duty of the two doctors carrying out the testing to be satisfied that the only explanation for the respiratory failure is due to the irreversible cessation of brain-stem function. A train of four examination, using a peripheral nerve stimulator, may be required. See above for 'Red Flag' patient groups.

	Test 1		Test 2	
Is the apnoea due to neuromuscular blocking agents, other drugs or a non brain-stem cause (*eg.* cervical injury, any neuromuscular weakness)? (ALL answers should be NO)	**Dr One Yes / No**	**Dr Two Yes / No**	**Dr One Yes / No**	**Dr Two Yes / No**

Tests for Absence of Brain-Stem Function

Guidance: A complete set of tests should be performed on each occasion, i.e., a total of two sets of tests will be performed. Doctor One may perform the tests while Doctor Two observes; this would constitute the first set. Roles may be reversed for the second set. The tests, in particular the apnoea test, are therefore performed only twice in total.

	Test 1		Test 2	
	Dr One Examining	**Dr Two** Observing	**Dr One** Observing	**Dr Two** Examining
Do the pupils react to light? The pupils are fixed and do not respond to sharp changes in the intensity of incident light. Cranial nerves II, III.	**Yes / No**	**Yes / No**	**Yes / No**	**Yes / No**
Is there any eyelid movement when each cornea is touched in turn? Corneal reflex - Cranial nerves V,VII. The use of sterile gauze is recommended.	**Yes / No**	**Yes / No**	**Yes / No**	**Yes / No**
Is there any eye movement seen during or following the slow injection of at least 50mls ice cold water over 1 minute into each ear with the head flexed at 30°? Each ear drum should be clearly visualised before the test. Vestibulo-ocular reflex - Cranial nerves III VI VIII.	**Yes / No**	**Yes / No**	**Yes / No**	**Yes / No**
Is the gag reflex present? Use a spatula or Yankauer sucker or laryngoscope to stimulate the posterior pharynx. Cranial Nerves IX, X.	**Yes / No**	**Yes / No**	**Yes / No**	**Yes / No**
Is the cough reflex response present when a suction catheter is passed down the trachea to the carina? Cranial Nerves IX, X.	**Yes / No**	**Yes / No**	**Yes / No**	**Yes / No**
Is there any motor response in a cranial nerve or somatic distribution when supraorbital pressure is applied? Cranial Nerves V,VII. Reflex limb and trunk movements (spinal reflexes) can be present.	**Yes / No**	**Yes / No**	**Yes / No**	**Yes / No**

Brain-Stem Reflexes

To diagnose death using neurological criteria, ALL answers should be NO

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Patient Name: **NHS / CHI Number:**

Tests for Absence of Brain-Stem Function

Preparation for the Apnoea Test

- Oxygenation and cardiovascular stability should be maintained through each apnoea test. Pre-oxygenate FiO_2 1.0.
- Allow $PaCO_2$ to rise to at least 6.0 kPa by reducing the minute ventilation prior to commencing the apnoea test. End tidal carbon dioxide can be used to guide the starting of each apnoea test but should not replace the pre and post arterial $PaCO_2$.
- Cardiac pulsation may be sufficient to trigger supportive breaths if the patient remains connected to the mechanical ventilator and on a spontaneous breathing mode. Performing the apnoea test whilst remaining on mechanical ventilation is not recommended.

Guidance

- CPAP circuit (eg Mapleson C) is recommended.
- Alternatively, disconnect the patient from the ventilator and administer oxygen via a catheter in the trachea at a rate of >6L/minute – watch for de-recruitment and flushing out $PaCO_2$.

Apnoea Test (the apnoea test is performed only twice in total)

	1st Test	2nd Test
Arterial Blood Gas PRE apnoea test: Confirm **$PaCO_2$ is at least 6.0 kPa** but not substantially greater. In patients with chronic CO_2 retention, or those who have received intravenous bicarbonate, it recommended that $PaCO_2$ is allowed to rise to above 6.5 kPa.	1st Test Starting $PaCO_2$: kPa Should be ≥6.0 kPa	2nd Test Starting $PaCO_2$: kPa Should be ≥6.0 kPa
PRE Arterial Blood Gas pH/[H^+]: Confirm **pH < 7.4** or **[H^+] >40 nmoles/L.**	pH= Should be < 7.4 [H^+]= Should be >40nmoles/L	pH= Should be < 7.4 [H^+]= Should be >40nmoles/L
Start time: Time when apnoea test was commenced.	hr : min (24 hour clock)	hr : min (24 hour clock)
Arterial Blood Gas POST apnoea test: Ensure the **$PaCO_2$ has increased by greater than 0.5 kPa.**	1st Test Stopping $PaCO_2$: kPa Should have increased by > 0.5	2nd Test Stopping $PaCO_2$: kPa Should have increased by > 0.5
Stop time: Time when apnoea test was ceased.	hr : min (24 hour clock) *Perform lung recruitment*	hr : min (24 hour clock) *Perform lung recruitment*

Was there any spontaneous respiration during a minimum of 5 (five) minutes continuous observation following disconnection from the ventilator? **(To diagnose death using neurological criteria, ALL answers should be NO)**	**Dr One**	**Dr Two**	**Dr One**	**Dr Two**
	Yes / No	**Yes / No**	**Yes / No**	**Yes / No**

Considerable atelectasis develops in the apnoeic period. At the conclusion of the apnoea test, manual recruitment manoeuvres should be carried out before resuming mechanical ventilation.

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Ancillary Investigations Used to Confirm the Diagnosis

Guidance

Ancillary investigations are **NOT** required for the diagnosis and confirmation of death using neurological criteria.

They may be useful however, where neurological examination is not possible (eg. extensive facio-maxillary injuries, residual sedation and some cases of paediatric hypoxic brain injury), where a primary metabolic or pharmacological derangement cannot be ruled out or in cases of high cervical cord injury, or where spontaneous or reflex movements in the patient generate uncertainty over the diagnosis. In such cases a confirmatory test may reduce any element of uncertainty and possibly foreshorten any period of observation prior to formal testing of brain-stem reflexes.

Any ancillary or confirmatory investigation should be considered **ADDITIONAL** to the fullest clinical testing and examination (as outlined above) carried out to the best of the two doctors capabilities in the given circumstances.

The utility of any additional investigation is for the two testing doctors to decide and they should seek further professional opinion from other specialities and other expert centres, where appropriate. Some possible ancillary investigations are:

- Clinical
  - Rotation of the head to either side should not produce any eye movement (absent doll's eyes response). This should NOT be performed if there is suspected or known cervical spine injury.
  - Administration of 2mg atropine should not lead to an increased heart rate (>3%).
- Neurophysiological demonstration of loss of bioelectrical activity in the brain (EEG, evoked potentials).
- Radiological demonstration of absent cerebral blood flow or brain tissue perfusion (CT angiography, 4 vessel angiography, transcranial doppler).

The interpretation of ancillary investigations is complex and their availability usually restricted to neurological centres.

Helpful references on ancillary testing

1. Wijdicks (2001) "The Diagnosis of Brain Death" NEJM 344:1215-21.
2. Young & Lee (2004) "A critique of Ancillary Tests for Brain Death." *Neurocritical Care;* 1:499-508.
3. Heran, Heran & Shemie (2008) "A review of ancillary tests in evaluating brain death." *Can J Neurol Sci*; 35:409–19.

Is there a need for any ancillary investigations?	**Dr One** **Yes / No**	**Dr Two** **Yes / No**

If yes please outline the results of these investigations:

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Patient Name: **NHS / CHI Number:**

Document any required Clinical Variance from AoMRC (2008) Guidance

Completion of Diagnosis

	Test 1		**Test 2**	
Are you satisfied that death has been confirmed following the irreversible cessation of brain-stem-function?	**Dr One** **Yes / No**	**Dr Two** **Yes / No**	**Dr One** **Yes / No**	**Dr Two** **Yes / No**
Legal time of death is when the 1st Test indicates death due to the absence of brain-stem reflexes. Death is confirmed following the 2nd Test.	**Date:** **Time:** Dr One signature Dr Two signature		**Date:** **Time:** Dr One signature Dr Two signature	

References & Resources

1. Academy of Medical Royal Colleges (2008) "A Code of Practice for the Diagnosis and Confirmation of Death" www.aomrc.org.uk
2. Report from the Organ Donation Taskforce (2008) "Organs for Transplant" www.dh.gov.uk
3. GMC (2010) "Treatment and care towards the end of life." www.gmc-uk.org
4. NICE (2011) "Organ Donation for Transplantation" http://guidance.nice.org.uk/CG135
5. Gardiner D, Shemie S, Manara A & Opdam H (2012) "International perspective on the diagnosis of death" BJA 108 Suppl 1:i14-28. BJA 108 Suppl 1:i14-28.
6. A series of helpful education videos are available: https://www.odt.nhs.uk/deceased-donation/best-practice-guidance/donation-after-brainstem-death/diagnosing-death-using-neurological-criteria/.

Form authorship and feedback

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Form for the Diagnosis of Death using Neurological Criteria {long version}

Attach Arterial Blood Gases

Additional NOTES