1. Introduction

Death occurs when there is permanent loss of capacity for consciousness and loss of all brainstem functions. This may result from permanent cessation of circulation and/or after catastrophic brain injury.

The diagnosis and confirmation of death is required in a number of different situations, both as a result of a natural process and also in situations where artificial interventions are sustaining cardiorespiratory function in the absence of a patient's ability to breathe independently. Unique to critical care, death may be diagnosed either following irreversible cessation of cardiorespiratory function – "Cardiac death" or following the irreversible loss of brain-stem reflexes, diagnosed by clinical neurological testing – "Brain-stem death."

This UHL guideline is based on "A code of practice for the diagnosis and confirmation of death" produced by the The Academy of Royal Colleges in 2008. It clearly states the preconditions and criteria clinician(s) need to diagnose death by cardiorespiratory and neurological criteria.

2. Scope

This guideline is relevant to all medical and nursing staff involved in patient care on Adult Critical Care Units at University Hospitals of Leicester NHS Trust.

3. Guideline Standards and Procedures

CARDIAC DEATH

Prior to confirming death by cardiorespiratory criteria **one** of the following must be fulfilled:

1. The individual meets the criteria for not attempting cardiopulmonary resuscitation
2. Attempts at cardiopulmonary resuscitation have failed
3. Treatment aimed at sustaining life has been withdrawn because it has been decided to be of no further benefit to the patient and not in his/her best interest to continue and/or is in respect of the patient's wishes via an advance decision to refuse treatment

Confirming Death by Cardiorespiratory criteria

- The individual should be observed by the person responsible for confirming death for a minimum of five minutes to establish that irreversible cardiorespiratory arrest has occurred. The absence of mechanical cardiac function is normally confirmed using a combination of the following:
    - Absence of a central pulse on palpation
    - Absence of heart sounds on auscultation
- As an alternative within critical care the following observations may be carried out where available for a minimum of five minutes:
    - Absence of pulsatile flow using direct intra-arterial pressure monitoring
    - Asystole on a continuous ECG display
    - Absence of contractile activity using echocardiography
- Any spontaneous return of cardiac or respiratory activity during this period of observation should prompt a further five minutes observation from the next point of cardiorespiratory arrest
- After five minutes of continued cardiorespiratory arrest the absence of the pupillary responses to light, of corneal reflexes, and of any motor response to supra-orbital pressure should be confirmed
    - The time of death is recorded as the time at which these criteria are fulfilled.

Form for the confirmation of Death by Cardiorespiratory criteria in Critical Care

Hospital ADDRESSOGRAPH or Surname ..... First Name..... Date of Birth..... Hospital number..... NHS Number.....	Date: Clinician responsible: Name..... Designation.....

Test	Test criteria	Observation and test criteria met?
Observation 1 – Arterial line in situ	Absence of pulsatile flow on arterial line trace for ≥ 5 minutes	YES / NO
Observation 2 – No arterial line in situ	Asystole on continuous ECG trace for ≥ 5 minutes	YES / NO
Observation 3 – No arterial line or ECG monitoring in situ, echocardiography available	Absence of cardiac contractions on echocardiography for ≥ 5 minutes	YES / NO
Observation 4 – No arterial line, ECG monitoring or echocardiography available	No heart sounds audible and no central pulse (carotid or femoral) palpable for ≥ 5 minutes	YES / NO
Observation 1,2,3 OR 4 confirmed?		**YES / NO**
Test 1 – Bilateral Pupillary reflex to light	Both pupils fixed and dilated	YES / NO
Test 2 – Bilateral corneal reflex	No response to corneal reflex bilaterally	YES / NO
Test 3 – Supra-orbital pressure	No motor response to supra-orbital pressure	YES / NO
Test 1,2 AND 3 confirmed?		**YES / NO**
Time that death was confirmed by Cardiorespiratory criteria (24hr clock)		
Signature		
Full name		
GMC number		

BRAIN-STEM DEATH

Brain-stem death occurs when the brain-stem has been damaged in such a way, and to such a degree, that its integrative functions (which include the neural control of cardiac and pulmonary function and consciousness) are irreversibly destroyed. At that point, death of the individual has occurred and the heart will inevitably stop beating subsequently, although the time over which this occurs may vary considerably.

Pre-conditions for confirming Death by Neurological criteria

All of the following criteria must be fulfilled prior to the patient being tested:-

1. There must be clear undisputable evidence for irreversible brain damage of known aetiology
    - In patients whose brain injury is anoxic damage following cardiorespiratory arrest a recommended minimum continued clinical observation period of 24hrs is undertaken. Where therapeutic hypothermia has been used this must follow re-warming to normothermia
2. Any reversible causes of coma and apnoea must be excluded, i.e:-
    - Come or apnoea not due to ongoing cardiorespiratory instability
    - Coma or apnoea not due to sedative/depressant drugs
    - Coma or apnoea not due to metabolic or endocrine disorder
    - Coma or apnoea not due to neuromuscular blocking agents, other drugs or a non brain - stem cause (eg cervical injury, any neuromuscular weakness)

Tests for absence of Brain-Stem function

Personnel

1. The diagnosis of death by neurological criteria should be made by at least two medical practitioners that have been registered with the General Medical Council for more than five years
2. At least one of the doctors must be a Consultant
3. Both doctors must 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

4. Neither doctor must have, or be perceived to have, any clinical conflict of interest or a be a member of the transplant team
5. Testing should be undertaken by the nominated doctors acting together and must always be performed on two occasions with a complete set of tests performed on each occasion. Doctor one performs the test while doctor two observes; this constitutes the first set. Roles should be reversed for the second test

Tests for absence of Brain-stem function

All of the following criteria must be met for a diagnosis of death by neurological criteria:-

1. The pupils and fixed and do not respond to sharp changes in the intensity of incident light
2. There is no corneal reflex
3. The oculo-vestibular reflexes are absent
4. No motor response within the cranial nerve distribution can be elicited by supraorbital pressure
5. There is no cough reflex response to bronchial stimulation by a suction catheter placed down the trachea to the carina, or gag response to stimulation of the posterior pharynx with a spatula
6. There is no respiratory response to hypercapnia (apnoea test)

Criteria 1,2 and 3 MAY be confirmed unilaterally IF local injury or disease prevents bilateral testing.

Ancillary investigations used to confirm the diagnosis

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

2. They may be useful where neurological examination is not possible e.g.

- Extensive facio-maxillary injuries
- Residual sedation suspected
- Metabolic or pharmacological deranged cannot be ruled out
- In cases of high cervical cord injury
- Where spontaneous or reflex movements in the patient generate uncertainty over the diagnosis

3. Any ancillary or confirmatory investigations should be considered ADDITIONAL to the fullest clinical testing and examination carried out to the best of the two doctors capabilities in the given circumstances

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

5. The utility of any additional investigation is for the two testing doctors to decide and they should seek further professional opinion from other specialties and other expert centres where appropriate.

6. Some possible ancillary investigations include:-

    - Clinical
        - Rotation of the head to either side should not produce any eve movements (absent doll's eyes response). Should not be performed if suspected or known cervical spine injury
        - Administration of 2mg intravenous 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)

Preparation checklist

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 (eg 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, 50ml luer lock syringe and disposable quill, ice-cold water, a spatula, Yankauer sucker or laryngoscopy, endotracheal suction catheters
    - Apnoea test: Haemodynamic monitoring (continuous ECG, invasive arterial pressure), arterial blood gas analysis including blood gas syringes x 4, pulse oximetry and end-tidal CO2 monitoring, means of delivering oxygen to the trachea by bulk flow (eg Mapleson C circuit which allows CPAP or endotracheal suction catheter and oxygen tubing)

Form for the confirmation of Death by Neurological criteria in Critical Care

Hospital ADDRESSOGRAPH or

Surname .....
First Name.....
Date of Birth.....
Hospital number.....
NHS Number.....

Date:

Doctor One
Name.....
Grade.....

Doctor Two
Name.....
Grade.....

EVIDENCE FOR IRREVERSIBLE BRAIN DAMAGE OF KNOWN AETIOLOGY

Primary Diagnosis:	
Evidence for irreversible brain damage of known aetiology:	

EXCLUSION OF REVERSIBLE CAUSES OF COMA AND APNOEA

Coma or apnoea not due to ongoing cardiorespiratory instability				
	1st test		**2nd test**	
Mean arterial pressure at time of testing? **Should be consistently > 60mmHg**	mmHg		mmHg	
$PaCO_2$ at time of testing? **Goal of normocarbia ($PaCO_3$ ≤6kPa) *if possible***	kPa		kPa	
PaO_2 at time of testing? **Avoid hypoxia (PaO_2 ≥ 10kPa) *if possible***	kPa		kPa	
pH at time of testing? **Aim for pH 7.35-7.45 *if possible***	pH =		pH =	
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**

Patient name: **NHS number:**

Coma or apnoea not due to sedative / depressant drugs				
	1st test		2nd test	
Where there is any doubt, specific drug levels should be measured (midazolam < 10mcg/L, thiopentone , 5mg/L)	Drug levels (if measured):		Drug levels (if measured:	
Antagonists such as flumazenil, naloxone and neostigmine may be used	Drug antagonists (if used):		Drug antagonists (if used):	
Residual neuromuscular blockade can be tested for 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

Coma or apnoea not due to endocrine or metabolic disorder				
	1st test		2nd test	
Body temperature at time of testing? Must be ≥ 34ºC	ºC		ºC	
Serum sodium at time of testing? Should be 115 – 160mmol/L	mmol/L		mmol/L	
Serum potassium at time of testing? Should be ≥ 2mmol/L	mmol/L		mmol/L	
Serum phosphate at time of testing? Should be 0.5 – 3.0 mmol/L	mmol/L		mmol/L	
Serum magnesium at time of testing? Should be 0.5 – 3.0 mmol/L	mmol/L		mmol/L	
Blood glucose at time of testing? Should be 3.0 – 20.0 mmol/L	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

Patient name: **NHS number:**

Coma or apnoea not due to neuromuscular blocking agents, other drugs or a non brain-stem cause (eg cervical injury, any neuromuscular weakness)				
	1st test		2nd test	
Residual neuromuscular blockade can be tested for by peripheral nerve stimulation	**Train of four (if measured):**		**Train of four (if measured):**	
Is the apnoea due to neuromuscular blocking agents, other drugs or a non brain-stem cause (eg cervical injury, any neuromuscular weakness 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**

Patient name: **NHS number:**

TESTS FOR ABSENCE OF BRAIN-STEM FUNCTION
CRANIAL NERVE TESTS

	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
Are the any eyelid movements when each cornea is touched in turn? **Corneal reflex. Cranial nerves V, VII**	YES / NO	YES / NO	YES / NO	YES / NO
Is there any eye movement seen during or following the slow injection of 50ml ice cold water over 1 minute into each ear with the head at 30º? **Each ear drum must be clearly visualised before the test.** **Cranial nerves III, VI, VIII**	YES / NO	YES / NO	YES / NO	YES / NO
Is a gag reflex present? **Use a spatula or Yankauer sucker or laryngoscope to stimulate posteriorpharynx** **Cranial nerves IX, X**	YES / NO	YES / NO	YES / NO	YES / NO
Is the cough reflex 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 of 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

Patient name: **NHS number:**

TESTS FOR ABSENCE OF BRAIN-STEM FUNCTION

APNOEA TEST

Disconnect the patient from the ventilator and connect to Mapleson C circuit or entrain oxygen via a suction catheter in the trachea

	Test 1		Test 2	
Arterial blood gas PRE apnoea test: Confirm $PaCO_2$ is at least 6.0kPa but not substantially greater. In patients with chronic CO_3 retention or those who have received intravenous bicarbonate it is recommended that $PaCO_2$ is allowed to rise above 6.5kPa	**Pre test $PaCO_2$** **kPa** should be ≥ 6.0 kPa		**Starting $PaCO_2$** **kPa** should be ≥ 6.0 kPa	
Arterial blood gas PRE apnoea test: Confirm pH < 7.4	**Starting pH** **pH =** should be < 7.4		**Starting pH** **pH =** should be < 7.4	
Start time: Time when apnoea test was commenced				
Arterial blood gas POST apnoea test Ensure the $PaCO_2$ has increased by greater than 0.5 kPa	**Post test $PaCO_2$** **kPa** should have increased by > 0.5 kPa		**Post test PaCO2** **kPa** should have increased by > 0.5 kPa	
Stop time: Time when apnoea test was ceased				
Was there any spontaneous respiration during a minimum of five minutes continuous observation following disconnection from the ventilator? **(To diagnose death using neurological criteria all answers should be NO)**	**YES / NO**	**YES / NO**	**YES / NO**	**YES / NO**

ANCILLARY INVESTIGATIONS USED TO CONFIRM THE DIAGNOSIS

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		

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**	

4. Education and Training

Guideline to be available to all staff working within critical care at UHL, with forms readily accessible for printing

Junior and senior medical staff to be informed of current guidelines within critical care and where to access the relevant information at local induction.

5. Monitoring and Audit Criteria

Element to be Monitored	Lead	Method	Frequency	Reporting arrangements
Compliance	Local audit leads for ICU	Snapshot Audit	2 yearly	To local consultant meeting Q and S board for assurance

6. Supporting References

1. Academy of the Medical Royal Colleges. A Code of Practice for the Diagnosis and Confirmation of Death. London; 2008. Available from www.aomrc.org.uk/reports.aspx

2. Form for the Diagnosis of Death Using Neurological Criteria (full guidance version) endorsed for use by the Faculty of Intensive Care Medicine, Intensive Care Society and the National Organ Donation Committee.2014, Available from https://www.ficm.ac.uk/sites/default/files/Form%20for%20the%20Diagnosis%20of%20Death%20using%20Neurological%20Criteria%20-%20Full%20Version%20%282014%29.pdf

7. Key Words

Diagnosis of death

Confirmation of death

Brainstem death

Critical Care

CONTACT AND REVIEW DETAILS	
Guideline Lead (Name and Title) Dr Caroline Sampson Consultant in Anaesthesia and ICM	**Lead Committee or Executive Lead** **ITU Head of Service**
Date of Next Review by Approval Committee: **September 2019**	**Details of Changes made during review:**