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SECTION 1

A CODE OF PRACTICE FOR THE DIAGNOSIS AND CERTIFICATION OF DEATH

Composition of the Working Party

This Revised Code of Practice has been prepared by a Working Party established through the Royal College of Anaesthetists on behalf of the Academy of Medical Royal Colleges and the English Department of Health. The document produced has been consulted upon widely through networks supplied by the Academy of Medical Royal Colleges and the Department of Health. Where considered appropriate by the Working Party, comments received have been incorporated into the final document. The membership of the Working Party was:

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CONTENTS

PARAGRAPH **PAGE**

SECTION 2 A code of practice for the management of the potential organ donor

Academy of Medical Royal Colleges / Department of Health April 2006

1. Introduction

The diagnosis and certification 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. This code of practice is designed to address the diagnosis and certification of death in all situations and to make practical recommendations which are acceptable both to the relatives of the deceased, to society in general and also to the medical, nursing and other professional staff involved. The working party has included some members of the group who drew up the 1998 Code of Practice and also new members to reflect the wider professional and lay interests that are now involved. We have drawn upon much of the comment received over the existing guidelines, together with documentation prepared in particular by the Intensive Care Society. (http://www.ics.ac.uk/downloads/Standards/Master%20ICS%20Guidelines%20all%20sections%20(Nov04).pdf)

This revised Code of Practice is a working document, aimed primarily at doctors and other healthcare workers who are responsible for the diagnosis and certification of death, rather than the lay public. For this reason, it has been written using medical terminology. Accepting, however, that it will be read more widely, we have included a glossary of the medical terms used in Appendix 5. Unlike the 1998 Code, this revised version has taken on a different format. The working group agreed that it was important to completely separate the diagnosis and certification of death from anything to do with the issues surrounding organ donation and transplantation. Thus, Section 1 deals with the diagnosis of death, whatever the cause, allowing this to be carried out in a variety of circumstances and always in the best interest of the patient. Section 2 is concerned with the management of the potential organ donor and is only relevant once a diagnosis of death has been established under the guidelines in Section 1. We intend that these two sections should be used in conjunction with the Guidelines from the Intensive Care Society, forming a portfolio of documents which are consistent and clearly linked.

It is our hope that the revised Code, like the original Code, will be of help to those concerned with the care of the dying, by reaffirming the criteria for the diagnosis of death whether following the irreversible cessation of cardio-respiratory function, or by testing

brain stem reflexes in comatose apnoeic ventilated patients with a heartbeat. When a patient is comatose, apnoeic and receiving artificial ventilation of their lungs, the criteria for determining irreversible cessation of brainstem function will be the irreversible loss of brain stem reflexes, diagnosed by clinical neurological testing. The Code also clarifies the certification of death following cardio-respiratory arrest. .

In this way, relatives, partners and carers may be spared the ordeal of witnessing an intervention which is prolonged but of no benefit to the patient. Equally, professionals ordinarily responsible for protecting life can be confident about the professional and legal acceptability of discontinuing interventions that merely serve to prolong somatic function.

It is essential that relatives, partners and carers be kept fully informed of the clinical condition of the patient and that they be given an explanation regarding the condition and prognosis. Relatives, partners and carers of the patient should be given explanation of the investigations being undertaken and of their interpretation throughout the process of the determination of death, in a sympathetic, timely and appropriate fashion by those concerned with the management of the patient.

2. Diagnosis and Certification of Death

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 certify death.

The current position in law is that there is no statutory definition of death in the United Kingdom. Subsequent to the proposal of the `brain death criteria' by the Conference of Royal Colleges in 1976[1,2], the courts in England and Northern Ireland have adopted these criteria, as part of the law, for the diagnosis of death.[3,4] There is no reason to believe that courts in other parts of the United Kingdom would not follow this approach.

Section 26(d) of the Human Tissue Act 2004 [5] empowers the Human Tissue Authority to develop a Code of Practice addressing the definition of death for the purposes of that Act only. Consultation with the Human Tissue Authority has ensured that these guidelines are consistent with the requirements of the Act[5].

For people suffering cardiorespiratory arrest (including failed resuscitation), death can be certified when a registered medical practitioner confirms the irreversible cessation of cardiac and respiratory activity. The doctor has to be certain that there has been irreversible damage to the vital centres in the brain stem, due to the length of time in which there has been inadequate circulation to the brain.

3. Certifying Death after Cardiorespiratory Arrest

Death after cardiorespiratory arrest has long been identified by the simultaneous and irreversible onset of apnoea and unconsciousness and absence of the circulation. In these circumstances irreversible cessation of brain stem function rapidly ensues. However, unlike certification of death using neurological assessment of cessation of brain stem reflexes (Sub-section 6), there are currently no standardised criteria for the certification of death following irreversible cessation of cardiorespiratory function. As a result current practice varies from certifying death as soon as an attempt at cardiopulmonary resuscitation is abandoned to waiting 10 minutes or longer after the onset of asystole and apnoea.

Whilst death is a process rather than an event, a definition of when the process reaches that point at which a living human being ceases to exist is necessary to allow the certification of death without an unnecessary and potentially distressing delay. We recommend that the point after cardiorespiratory arrest at which death of a living human being occurs is identified by the following conditions:

- The simultaneous and irreversible onset of apnoea and unconsciousness in the absence of the circulation

- No reversible factors are causing or contributing to the cardiorespiratory arrest. Such factors, which include body temperature, endocrine, metabolic and biochemical abnormalities are considered under paragraph 5.

- One of the following is fulfilled:
  - The individual meets the criteria for not attempting cardiopulmonary resuscitation [6]
  - Attempts at cardiopulmonary resuscitation have failed
  - Treatment 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 in respect of the patient's wishes

- The individual should be observed for a full 5 minutes[7,8] to confirm that irreversible cardiorespiratory arrest has occurred. The absence of mechanical cardiac function can be confirmed with increasing accuracy using any one or combination of the following:
  - absence of a central pulse on palpation
  - absence of heart sounds on auscultation
  - asystole on a continuous ECG display
  - absence of pulsatile flow using direct intra-arterial pressure monitoring
  - absence of contractile activity using echocardiography

- Given, as above, that no further attempts are planned to restore the circulation, 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 5 minutes of continued cardiorespiratory arrest the absence of the pupillary responses to light, of the 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.

It is obviously inappropriate to initiate any intervention that has the potential to restore coronary or cerebral perfusion, including chest compressions or the institution of cardiopulmonary bypass after death has been certified.

It is accepted that further studies are required to help understand the conditions under which cardiac auto-resuscitation (spontaneous re-starting of the heart) may occur and to refine further the definition of the appropriate time interval between the cessation of cardiorespiratory function and the declaration of death.

4. Diagnosis and Certification of Death in a Patient in Coma

When managing a patient in coma, the first objective for the healthcare team is to determine the cause and degree of coma, to maintain life by any necessary means, and to attempt to restore function. Such measures are often successful, but 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, the death of the individual has occurred and the heart will inevitably stop beating shortly thereafter. When this has been established by the methods to be described, the patient is dead even though respiration and circulation can be artificially maintained. The appropriate course of action is then to withdraw mechanical respiratory support, the time for which has passed. This otherwise imposes a pointless and distressing vigil on the relatives, partners and carers who should be kept fully informed by the local care team of the diagnosis and likely prognosis.

5. Conditions under which the Diagnosis of Death Following Irreversible Cessation of Brain Stem Function should be considered - (All must be fulfilled)

5.1 There should be no doubt that the patient's condition is due to irreversible brain damage of known aetiology.

It may be obvious within hours of a primary intracranial event such as a severe head injury, or spontaneous intracranial haemorrhage that the condition is irreversible. When, however, a patient has suffered primarily from cardiac arrest or severe circulatory insufficiency with an ill-defined period of cerebral hypoxia or a cerebral air or fat embolism, it may take longer to establish the diagnosis and to be confident of the prognosis. In some patients the primary pathology may be a matter of doubt and a confident diagnosis may only be reached by continuing clinical observation and investigation.

5.2 The patient is deeply comatose, unresponsive and apnoeic, with his/her lungs being artificially ventilated.

5.2.1 There should be no evidence that this state is due to depressant drugs. Narcotics, hypnotics and tranquillisers may have prolonged action, particularly when hypothermia coexists or in the context of renal or hepatic failure. The benzodiazepines are markedly cumulative and persistent in their actions and are commonly used as anticonvulsants or to assist synchronisation with mechanical ventilators. It is therefore essential that the recent history of what drugs have been taken or administered should be carefully reviewed and any possibility of intoxication being the cause of, or contributing to, the patient's comatose state should preclude a diagnosis of death. It is important to recognise that, in some patients, hypoxia may have followed the ingestion of a drug but in this situation the criteria for death will not be applicable until such a time as the primary effects of the drug have been excluded as a continuing cause of the unresponsiveness.

5.2.2 Primary hypothermia as the cause of unconsciousness must have been excluded.
Temperatures between 32-34°C are occasionally associated with an impaired level of consciousness but brainstem reflexes tend to be lost if the temperature falls below 28°C. These deficits are potentially reversible. In clinical practice patients remain awake and conscious with temperatures > 34°C unless other factors are present. We recommend that the core temperature should be greater than 34°C at the time of testing.

5.2.3 Potentially reversible circulatory, metabolic and endocrine disturbances must have been excluded as the cause of the continuation of unconsciousness.
While trying to provide broad guidance on the magnitude of metabolic and endocrine disorders which are likely to influence the testing of brain stem reflexes, it is essential to bear in mind that the most important factor is the establishment of an unequivocal cause for the individual's unconsciousness.

It is recognised that circulatory, metabolic and endocrine disturbances (e.g. hypernatraemia, diabetes insipidus) are likely accompaniments of death as a result of cessation of brain stem function. It is important to emphasise that these may be the effect rather than the cause of cessation of brain stem function and do not preclude the

diagnosis of death by neurological testing of brain stem reflexes. Furthermore it may be detrimental to correct such abnormalities too rapidly and, equally, to delay testing of brain stem reflexes unnecessarily simply because of strict adherence to the requirement to attain a pre-determined blood electrolyte concentration.

As guidance, we would emphasise that the effects of hyponatraemia depend on the rate of development but it is rare for patients to become unresponsive if the serum sodium concentration is 115mmol/L or above. If severe hyponatraemia is corrected too rapidly the patient may develop unresponsive but potentially reversible coma due to central osmotic myelinolysis. Sodium levels above 160mmol/L are associated with unresponsiveness and this should be born in mind if the primary cause of coma prior to testing is uncertain.

Profoundly low levels of serum potassium may cause myopathy and levels below 1mmol/L have been reported to cause flaccid quadriplegia. Whilst there is no clear evidence concerning the central effects of hypokalaemia, as a guide, we would recommend that testing of brain stem reflexes should not be undertaken in the face of a serum potassium concentration below 2mmol/L.

Similarly, profound hypophosphataemia and hypomagnesaemia are associated with severe neuromuscular weakness that may culminate in flaccid quadriplegia. Although there is little evidence to suggest a central component or to guide the clinician in determining at what levels brainstem testing can safely be undertaken, clinically significant weakness is unlikely unless levels of magnesium or phosphate are extremely low.

Hyperglycaemia in diabetic ketoacidosis or hyperosmolar non ketotic coma may cause a state of unresponsiveness which mimics brain death but this state is extremely unlikely with blood glucose levels less than 20mmol/L. Severe hypoglycaemia is associated with coma or stupor and testing of brain stem reflexes should not be undertaken if the glucose level is below 2 mmol/L. Since blood glucose concentrations change rapidly in critically ill patients, a ‘BM’ check should always made at the time of neurological testing of brain stem reflexes.

Patients in thyroid storm may present in acute coma or with acute thyrotoxic myopathy. Myxoedema may also cause a deep unresponsive coma. Addisonian crisis may be associated with severe neuromuscular weakness causing an acute ascending paralysis or encephalopathy proceeding to coma. These conditions are extremely rare and unlikely to co-exist in the presence of known primary pathologies. If there is any clinical reason to expect these disturbances then it is obligatory to ensure appropriate hormonal assays are undertaken.

5.3 The patient is being maintained on the ventilator because spontaneous respiration has ceased.

Relaxants (neuromuscular blocking agents) and other drugs must have been excluded as the cause of respiratory inadequacy or failure. Immobility, unresponsiveness, and lack of spontaneous respiration may be due to the use of neuromuscular blocking drugs and the persistence of their effects should be excluded by elicitation of deep tendon reflexes or by the demonstration of adequate neuromuscular conduction with a conventional nerve stimulator. Persistent effects of hypnotics or narcotics must be excluded as the cause of respiratory failure. Profound neuromuscular weakness resembling the absence of brain stem reflexes may occur as a consequence of a number of neurological disorders emphasising the importance of establishing a clear diagnosis of irremediable brain damage of known aetiology.

When coma follows a head injury, the presence of a cervical spine injury must be excluded in the usual way using clinical criteria, plain X-rays and CT scans as indicated. If there are reasons to suspect that an underlying high cervical spine injury and associated cord injury are causing the apnoea, then the apnoea test (6.1.6) becomes invalid. In this rare scenario, cessation of brain stem function can only be established by confirming the absence of other brain stem reflexes and by using ancillary investigations such as 4-vessel angiography.

6. The Diagnosis of Death Following Irreversible Cessation of Brain Stem Function

Fulfilment of the clinical criteria for the diagnosis of death following irreversible cessation of brain stem function, specified by the Conference of Colleges during the period 1976-1981, is followed by cessation of the heart beat within a short period[1,2,9,10]. This has been confirmed in all published series and has therefore been adequately validated. Concern is sometimes expressed over continuing function within the brainstem,

occurring beneath the level at which any motor, somatosensory or breathing reflexes can be elicited and also continuing function in other parts of the brain, but both are irrelevant when evaluating function against these clinical criteria of death resulting from irreversible cessation of brain stem function. The following paragraphs recapitulate the criteria in the conference guidelines, with the addition of notes on how they may be elicited.

6.1 All brain stem reflexes are absent.

6.1.1 The pupils are fixed and do not respond to sharp changes in the intensity of incident light.

6.1.2 There is no corneal reflex - care should be taken to avoid damage to the cornea.

6.1.3 The oculo-vestibular reflexes are absent. No eye movements are seen during or following the slow injection of at least 50mls of ice cold water over one minute into each external auditory meatus in turn. Clear access to the tympanic membrane must be established by direct inspection and the head should be flexed at 30^{o} to the horizontal plane.

In the case of 6.1.1, 6.1.2 and 6.1.3, testing of these reflexes may be prevented on one or other side by local injury or disease but this does not invalidate the diagnosis of death as a result of cessation of brain stem reflexes.

6.1.4 No motor responses within the cranial nerve distribution can be elicited by adequate stimulation of any somatic area. No motor response can be elicited within the cranial nerve or somatic distribution in response to supraorbital pressure.

6.1.5 There is no gag reflex or reflex response to bronchial stimulation by suction catheter placed down the trachea.

6.1.6 The process for testing the respiratory response to hypercarbia (Apnoea test) should be the last brain stem reflex to be tested and should not be performed if any of the preceding tests confirm the presence of brain stem reflexes. Confusion has arisen in the past over the way in which the test should be performed and the frequency with which it should be repeated. This guidance deals specifically with these problems and

the testing process also takes into account the developments in monitoring that have occurred. The general availability of end tidal carbon dioxide (E_TCO_2) monitoring and instant access to blood gas analysis allows their routine utilisation to:

- eliminate the risk of the development of significant hypoxia during the apnoea test
- minimise the risk of the development of excessive hypercarbia and /or rapid changes in carbon dioxide tension
- minimise the development of changes in mean arterial pressure

and as a result, minimise the risk of further injury to potentially recoverable brain tissue, in case death of the brain stem has not actually occurred. Since blood glucose concentrations change rapidly in critically ill patients, a 'BM' check should also always made at the time of neurological testing of brain stem reflexes.

When the patient is not acidotic, the procedure recommended to induce moderate hypercarbia and acidosis is as follows:

- Increase the patient's FiO_2 to 1.0.
- Check arterial blood gases to confirm that the measured P_aCO_2 and S_aO_2 correlate with the monitored values
- With oxygen saturation greater than 95%, reduce minute volume ventilation, by lowering the respiratory rate, to allow a slow rise in E_TCO_2
- Once E_TCO_2 rises above 6.5KPa, check arterial blood gases to confirm that P_aCO_2 is at least 6.5KPa and that the pH is less than 7.35.
    - The aim should be to ensure this, and not a substantially greater, degree of hypercarbia and acidosis is achieved for those with no previous history of respiratory disease.
    - In patients with chronic CO_2 retention, the achievement of a mild but significant acidaemia as described would be achieved by allowing the P_aCO_2 to rise to above 6.5KPa to a point where the pH is less than 7.35.
- At this point the patient's blood pressure should be maintained at a stable level and the ventilation adjusted to ensure a steady state for mean arterial pressure and P_aCO_2 for 10 minutes.
- If cardiovascular stability is maintained, the patient should then be disconnected from the ventilator and attached to an oxygen flow of 5L/min via an endobronchial catheter and observed for 5 minutes
- If the maintenance of adequate oxygenation proves difficult, then CPAP (and possibly a prior recruitment manoeuvre) may be used

- If, after 5 minutes, there has been no spontaneous respiratory response, a presumption of no respiratory centre activity will be documented and a further confirmatory arterial blood gas sample obtained to ensure that the P_aCO_2 remains above 6.5KPa.
- The ventilator should be reconnected and the minute volume adjusted to allow a gradual return of the blood gas concentrations to the levels set prior to the commencement of testing.

6.2 Children.

A report of a working party of the British Paediatric Association of 1991 supported by the Council of the Royal College of Physicians suggested that, in children over the age of 2 months, the criteria used to establish death should be the same as those in adults. Between 37 weeks of gestation and 2 months of age, it is rarely possible confidently to diagnose death as a result of cessation of brain stem reflexes and below 37 weeks of gestation, the criteria to establish this cannot be applied [(11)]. This document endorses the 1991 report, which is reproduced in full as Appendix 4 without any modification of the original text. The text of the report is preceded in the Appendix by an introductory section indicating how the 1991 report should be read in relation to the current (2005) report.

6.3 Repetition of testing.

The diagnosis of death by brain stem testing should be made by at least two medical practitioners who have been registered for more than five years and are competent in the conduct and interpretation of brain stem testing. At least one of the doctors must be a consultant. Testing may be undertaken by each of the nominated doctors alone or together and must always be performed on two occasions in total. A complete set of tests should be performed on each occasion. If working alone, it is not recommended that both doctors each perform the tests on two separate occasions, since this may result in unnecessary physiological insult to the patient. In practice either Doctor A performs the first set and Doctor B the second set, or alternatively, they perform both sets together. Working together, with one performing the tests whilst the other observes, may be particularly useful for training purposes.

The timing of the interval between the tests is a matter for clinical judgement but the time should be adequate for the reassurance of all those directly concerned. The interval

between the tests will depend upon the primary pathology, the clinical course of the disease and the progress of the patient. Although death is not pronounced until the second test has been completed the legal time of death is when the first test indicates death due to the absence of brain stem reflexes and therefore function[7].

6.4 The beating heart in individuals certified dead as a result of cessation of brain stem reflexes.

Even if ventilation is continued both adults and children will suffer cessation of heart beat within a few days, very occasionally a few weeks, of the diagnosis of death as a result of cessation of brain stem reflexes.

6.5 Endocrine, metabolic and circulatory abnormalities.

Abnormalities, such as diabetes insipidus, hypo or hypernatraemia, hypothermia and disturbance of cardiac rhythm or blood pressure commonly occur in patients who suffer death of the brain stem following anoxic, haemorrhagic or traumatic cerebral injury. These abnormalities are a direct result of brain stem failure and must be differentiated from abnormalities of endocrinological, biochemical or autonomic function contributing to impaired brain stem function.

6.6 Limb and trunk movements.

Reflex movements of the limbs and torso may occur after death has been diagnosed. The doctor must explain clearly the significance of these movements to relatives, nurses and other staff who should be given sufficient information to enable them to understand that they are of spinal reflex origin and do not involve the brain at all.

6.7 Investigations

The accuracy of the clinical criteria for the diagnosis of death as a result of cessation of brain stem reflexes over the past 30 years provides justification for not including the results of neurophysiological or imaging investigations as part of these criteria. However, death cannot be diagnosed by testing of brainstem reflexes alone in instances where a comprehensive neurological examination is not possible (e.g. extensive facio-maxillary injuries 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 (5.3). In such cases a confirmatory test may reduce any element of uncertainty and possibly foreshorten any period of observation prior to formal testing of brainstem

reflexes. All ancillary investigations require expertise both to perform and to interpret, which may not be available in all hospitals or outside normal office hours. In this situation, further time may be required before death may be confirmed. Patients with the provisional diagnosis of irreversible cessation of brain stem reflexes are frequently physiologically unstable and their transfer to another part of the hospital for further investigation may carry a significant risk, were the diagnosis to prove subsequently to be wrong. All such investigations are prone to artefact and each has attracted its own literature defining false positive and negative rates. The various tests available, together with an assessment of their relative benefit and complexity are listed in Appendix 3.

6.8 Peripheral neurological syndromes of intensive care.

There is a range of overlapping neuropathic, neuromuscular and myopathic syndromes which may occur in the context of intensive therapy and may cause problems in weaning a patient from a ventilator. This is not true apnoea (respiratory centre paralysis) and should not be taken as evidence for neurological testing of brain stem function.

6.9 The permanent vegetative state.

Problems relating to the diagnosis and management of the permanent vegetative state must not be confused with those relating to death and the guidelines endorsed by the Conference of the Royal Colleges emphasise the important differences[12].

7. Management of the Patient

7.1 Maintenance of therapy.

The maintenance of normal homeostasis by attempting to ensure adequate fluid intake, electrolyte balance, normal blood pressure, the monitoring of urine output by catheter collection and the use of other therapeutic agents, is part of the standard medical care of the patient where death has not been conclusively established.

7.2 Cessation of Respiration.

Some patients who are thought to have sustained irreversible brain damage and are receiving partial ventilatory assistance may continue to make respiratory efforts, precluding the certification of death. In such patients it is important to decide at an early stage whether it is appropriate to initiate full mechanical ventilation at the onset of

apnoea, to allow the exclusion of other causes for the deterioration and to allow the certification of death by confirming the irreversible cessation of brain stem function. If this course of action is not considered appropriate nor in the patient's best interests, then neither is the inadequate level of support being provided. In such a case, withdrawing ventilatory assistance following discussion with the patient's relatives may be the most appropriate course. In deciding which relative to involve in decisions of this nature, we recommend following the hierarchy of qualifying relationships under Section 27(4) of the Human Tissue Act 2004[5].

7.3 Elective Ventilation.

Very occasionally it may be considered certain that respiratory arrest will inevitably occur shortly, as in the case of gross cerebral trauma or cerebral haemorrhage, but death has not yet been established. In these cases endotracheal intubation and artificial ventilation of the patient should not be undertaken solely to preserve organ function. The Health Departments have advised that ventilation in these circumstances is unlawful[13], and a substantial body of healthcare practitioners would regard the practice as unethical. It cannot be demonstrated to be for the benefit of the patient (and may indeed run the risk of causing serious harm). The agreement of the relatives to elective ventilation does not alter the legal position (see above).

7.4 Organ and Tissue Donation

Many patients who die in certain circumstances and situations, including in a critical care facility, may be suitable for organ and/or tissue donation and their wishes and the wishes of their relatives, partners and carers should be established in order that this may be facilitated when appropriate. Section 2, together with the Intensive Care Society guidelines provide for this.

Appendix 1.

Procedure for the Diagnosis and Management of Cessation of Brain Stem Function by Neurological Testing of Brain Stem Reflexes

Diagnosis is to be made by two doctors who have been registered for more than five years and are competent in the procedure. At least one should be a consultant. Testing may be undertaken by each of the doctors alone or together and must always be performed on two occasions in total.

Name: Unit No:

Pre-Conditions
Are you satisfied that the patient suffers from a condition that has led to irreversible brain damage?
Specify the condition:

Dr A: ..... Dr B:…….

Time of onset of unresponsive coma:

Dr A: ..... Dr B:……..

Are you satisfied that potentially reversible causes for the patient's condition have been adequately excluded, in particular:

	Dr A	Dr B
Depressant drugs		
Neuromuscular blocking drugs		
Hypothermia		
Metabolic or endocrine disturbances		

Tests for absence of brain stem function	1st Set of Tests (Dr A)	2nd Set of Tests (Dr B)
Do the pupils react to light?		
Are there corneal reflexes?		
Is there eye movement on caloric testing?		
Are there motor responses in the cranial nerve distribution in response to stimulation of face, limbs or trunk?		
Is there a gag reflex?		
Is there a cough reflex?		
Have the recommendations concerning testing for apnoea been followed?		
Were there any respiratory movements seen?		

Date and time of first testing: .....

Date and time of second testing: .....

Dr A Signature: ..... Dr B Signature: .....

Status: ..... Status: .....

Appendix 2. Diagnostic and Management Algorithm

Identification of Coma

? Yes

Clinical evidence of cause of coma
(possibly supported by neuroimaging, neurophysiology, CSF, etc.)

? Yes

Exclusion of hypothermia, intoxication, sedative drugs, neuromuscular blocking agents, severe electrolyte, acid base or endocrine abnormalites as causative

? Yes

Absent Brain Stem Reflexes
Absent Motor Response
Apnoea PCO_2 ? 6.5KPa
These procedures should be clearly explained to relatives, partners and carers

? Yes

CLINICAL DIAGNOSIS OF DEATH

? Eligible for Organ Donation

? Yes **? No**

Proceed with Enquiries and Testing Prior to Organ Donation

Disconnect from Ventilator

Appendix 3: Summary and assessment of the relative benefit and complexity of the various neuroradiological and neurophysiological tests that are available.

Test	Reliability / Accuracy	Availability	Portability	Expertise to perform	Ease of interpretation	Risks
Blood flow in the larger cerebral arteries:						
4 vessel Angiography	good	neuroscience units	not	high	good	<1%
Transcranial Doppler	mixed	variable	yes	high	not always straightforward	0
MR angio	?	variable	not	high	?	minimal
Brain tissue perfusion:						
HMPAO SPECT	good	limited	not	moderate	not always straightforward	0
Xenon CT	?	limited	conventional CT - not portable CT - possible	high	?	0
Positron Emission Tomography	good	very restricted	not	high	good	0
Neurophysiology:						
EEG	mixed	variable	yes	high	not always straightforward	0
Evoked potentials	good	variable	yes	high	good	0

[Reliability/accuracy as reflected by the literature which is often sparse and anecdotal. There is insufficient literature on such new techniques as MR spectroscopy and diffusion weighted imaging to form any opinion. All these tests require that the operator is performing such examinations frequently for other reasons and is confident in their knowledge and understanding of the artefacts and pitfalls in their application to the diagnosis of irreversible cessation of brainstem reflexes.]

Appendix 4. 1991 report of a working party of the British Paediatric Association on the diagnosis of brain stem death in infants and children

This document endorses the 1991 report, which is reproduced in full below, without any modification of the original text. The following remarks below indicate how the 1991 report should be read in relation to these current guidelines.

1. Terminology

The concepts of 'brain death' and 'brain stem death' are not employed in this report. The terminology that has been adopted in this report rests on the concept of a unitary state of death, as defined in the introduction. The terminology in this report can be substituted for the form of words selected within the 1991 report, as already indicated in the introductory section.

2. Children older than two months

Part b) of this section of the 1991 report. The pre-conditions specified in the 1991 report are a subset of the pre-conditions laid out under paragraph 5 in Section 1 of these guidelines. The working party recommends that the pre-conditions in both the 1991 and this report should be fulfilled.

Part c) of this section of the 1991 report. The qualifications specified are no longer applicable as the 'senior registrar' grade no longer exists. The working party recommends that the assessments should be carried out, as specified in the guidelines, by at least two medical practitioners who have been registered for more than five years, have been trained in this field and are not members of the transplant team. In addition one of them should be a consultant, one of them should normally be a paediatrician or should have experience with children and one of them should not be primarily involved in the child's care.

3. 37 weeks to 2 months of age and infants below 37 weeks gestation

The working party supports the conclusions and recommendations of the 1991 working party.

4. Appendix to 1991 report

The criteria and exclusions for the diagnosis of death following irreversible cessation of brain stem function in children older than two months and adults are laid out more fully in Sections 5 and 6 of these 2005 guidelines which should be used in preference to the appendix of the 1991 report.

The appendix of the 1991 report lists one criterion in the procedure for 'testing for brain stem death' that is not mentioned in the equivalent sections of this 2005 or previous working party reports, viz 'No Doll's eye reflex'. However the oculomotor responses to caloric stimulation and passive head turning relate to each other as if the two stimuli differed only in degree, the first being stronger than the second. The only conditions in which absence of caloric responses accompanies preserved oculo-cephalic responses are bilateral lateral brainstem lesions involving the vestibular nuclei or destruction of both labrynths (e.g. streptomycin toxicity).[14] The 2005 working party does not consider it necessary to include the Doll's eye reflex when establishing the presence of irreversible and non-survivable cessation of brain stem function in any age group.

Diagnosis of Brain Stem Death In Infants and Children

A Working Party Report of the
British Paediatric Association

November 1991

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Summary of Conclusions and Recommendations

These guidelines apply to infants and children who are comatose, totally apnoeic, and being ventilated.

1. Children older than two months. The working party recommends that:

   a) The formal assessment of brain stem death is approached in an unhurried manner and time is spent ensuring that all the pre-conditions are satisfied.

   b) It is prudent to measure body levels of barbiturates (or other drugs) to confirm that they play no part in potentiating coma. Reversal of neuromuscular blockade must be demonstrated, by the presence of peripheral reflexes or by response to nerve stimulation.

   c) The assessment should be carried out separately by two experienced clinicians or consultant or senior registrar status; at least one should be a paediatrician, one should be a consultant, and one should not be primarily involved in the child's care.

2. 37 weeks gestation to 2 months of age

   The working party concluded that given the current state of knowledge it is rarely possible confidently to diagnose brain stem death at this age.

3. Infants below 37 weeks gestation

   The working party concluded that the concept of brain stem death is inappropriate for infants in this age group. Decisions on whether to continue intensive care should be based on an assessment of the likely outcome of the condition, after close discussion with the family.

4. Electrophysiological measurements in infants and children

   The working party did not feel confident, given the correct state of knowledge, that these investigations are a helpful addition to the diagnosis of brain stem death.

*Anencephalic infants are not considered in this report; use of their organs for transplantation was the subject of a report of a working party of the Conference of Medical Royal Colleges and their Faculties in the United Kingdom (1)

Introduction

The awareness that a patient may be brain dead whilst still mechanically ventilated arose in the 1970's in parallel with improvements in intensive care. Clearly it would be futile to continue supporting such a patient if there was certainty that their brain was irreversibly damaged. The debate culminated in the publication in 1976 of the Conference of medical Royal Colleges' memorandum "The diagnosis of brain death" (2), which set out the clinical criteria to be satisfied before stopping ventilating a comatose adult. These guidelines form the basis of clinical practice in all adult intensive care unite and neurological centre.

Paediatricians and especially neonatologists, are able to offer sophisticated intensive care to even the most immature infants and are now addressing the question of when to stop ventilating an infant whose brain is irretrievably damaged. The American Task Force (1987) set out the clinical criteria they considered to be valid for the diagnosis of brain death in infants and children (3).

The Concept of Brain Stem Death

Pallis defines death as "the irreversible loss of the capacity for consciousness, combined with irreversible loss of the capacity to breathe" (4). These functions depend on the integrity of the brain stem. There is evidence to show that for a patient with severe structural brain damage, if all the brain stem death criteria are satisfied, asystole will inevitably follow within a few days despite continued ventilation (5). In adults 50% of the cases of brain death follow severe head injury, 30% are due to subarachnoid haemorrhage and 20% are due to a severe hypoxic-ischaemic event. Thus supra-tentorial catastrophes lead to pressure effect which cause the irretrievable death of the brain stem. In adult neurosurgical and intensive care units the ability to diagnose brain stem death has positive advantages for the staff and relatives caring for a deeply comatose patient. Once the news that the patient is brain dead is accepted, relatives usually agree that stopping ventilation is the logical and kindest next step. The opportunity to retrieve organs for transplantation then arises but should never be the reason for arriving at a diagnosis of brain stem death.

The Clinical Criteria

The criteria for diagnosing brain stem death are tabulated in the Appendix.
All the pre-conditions must be satisfied and there should be demonstrably no pharmacological or metabolic reason for the coma before formally testing the integrity of the brain stem reflexes. Persistent absence of these reflexes demonstrates widespread damage in the medulla and pons. The first two stages of the assessment are mandatory and emphasise that the assessment of a comatose patient should never be hurried. The formal testing of brain stem reflexes is usually carried out 12-24 hours apart by two experienced clinicians.

The family often enquire about the possibility of organ donation and intensive care and neurological units are familiar with local arrangements for organ retrieval.

Physiological Measurements Used to Assess Brain Function

In adults it is generally agreed that EEG recordings in isolation are of no prognostic value and indeed an iso-electric recording may be compatible with survival. Radio-isotope, angiographic and Doppler techniques have been used to measure cerebral blood flow in adults and children. They are complex to carry out and low or absent cerebral blood low does not necessarily equate with brain stem death.

Brain stem evoked potentials are a relatively new techniques whose value is still being assessed in comatose patients but may be open to the same criticisms as EEG recording.

Pallis concludes that such investigations add nothing to the bedside assessment of brain stem death using the normal clinical criteria (4).

Application of the Established Criteria for the Diagnosis of Brain Stem Death to Children

The working party drew a very clear distinction between cessation of ventilation when the diagnosis of brain stem death has been confirmed, and the agreed withdrawal of intensive care in a severely brain damaged child whose prognosis is deemed to be severe disability or a vegetative state.

This is a particular dilemma in the newborn as it is relatively uncommon to see infants who are clearly brain stem dead. Volpe and Robinson emphasise this distinction and argue that withdrawal of life support systems is acceptable solely on the basis of the best interests of a devastatingly ill infant (6,7). The working party fully endorses this concept.

Children Older Than Two Months

There is a general agreement in the USA that the criteria for assessing brain death in adults are applicable. Clearly this presupposes an accurate assessment of the severity of the structural brain damage. This may be obvious from CT scanning in the case of trauma or cerebral haemorrhage but may not be assessed so easily when coma is due to an hypoxic-ischaemic encephalopathy or complicated multisystem failure.

The working party recommends that:

a) The formal assessment of brain stem death is approached in an unhurried manner and time is spent ensuring that all the re-conditions are satisfied.
b) It is prudent to measure blood levels of barbiturates (or other drugs) to confirm that they play no part in potentiating coma. Reversal of neuromuscular blockade must be demonstrated, by the presence of peripheral reflexes or by response to nerve stimulation.
c) The assessment should be carried out separately by two experienced clinicians of consultant or senior registrar status: one should normally be a paediatrician or should have experience with children, one should be a consultant, and one not primarily involved in the child's care.

37 Weeks Gestation to 2 Months of Age

The working party recognised that in this age group coma may occur for a wide variety of reasons. Perhaps the most common is an hypoxic-ischaemic encephalopathy, especially when the cerebral insult occurred in utero or at the time of birth. Such infants are very difficult to assess. It may not be possible satisfactorily to demonstrate structural brain damage and the infant may have multisystem failure. On these grounds alone is could be argued that brain stem death should not be diagnosed.

In the USA, the Task Force considers that in certain infants, after a period of observation, it may be possible to satisfy all the pre-conditions for the diagnosis of brain stem death. They recommend two formal clinical examinations of brain stem function at least 48 hours apart together with an iso-electric EEG (3). Whilst there is no evidence that the standard criteria of brain stem death will falsely identify infants in this age group as brain stem dead, there is no published evidence that if ventilation is continued, asystole will follow in a few days. Such evidence was considered important in the development of the concept of brain stem death in adults.

The working party CONCLUDED that given the current state of knowledge it is rarely possible confidently to diagnose brain stem death at this age.

Infants Below 37 Weeks Gestation

Apnoea and coma are common in this age group. It is extremely difficult to demonstrate irreversible brain damage in this age group, whilst hypoxia often is a complicating factor.

The development of brain stem reflexes in the pre-term infant has not been systematically studied. There are no data on the development of the caloric reflex, whilst the pre-term infant may not respond to the tracheal stimulation by suction. Thus normal preterm infants may fail to respond to some of the diagnostic tests for brain stem death. Because the path-ways in the brain stem are incompletely myelinated in very preterm infants, it is likely that major damage in this region will have different effects to those seen in older children or adults.

Thus the working party CONCLUDED that the concept of brain stem death is inappropriate for infants in this age group. Decisions on whether to continue intensive care should be based on an assessment of the likely outcome of the condition, after close discussion with the family.

Electrophysiological Measurements in Infants and Children

The working party reviewed the limited data available on the use of EEG, brain stem potentials and blood flow measurements in children.

Although the American guidelines accept an iso-electric EEG as supportive evidence of brain death (3), the working party did not feel confident that this investigation was of value in the diagnosis of brain death.

Radio-isotope or Doppler techniques for measuring cerebral blood flow are still being evaluated in children and neonates. They are only available in specialised centres and reports suggest that cerebral blood flow may be normal even when the child is brain stem dead.
The working party did not feel confident, given the current state of knowledge, that these investigations are a helpful addition to the diagnosis of brain stem death.

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Appendix

The Criteria for Diagnosis of Brain Stem Death

Pre Conditions

1. The patient is comatose and mechanically ventilated for apnoea.

2. The diagnosis of structural brain damage has been established or the immediate cause of coma is known.

3. A period of observation is essential.

Exclusions

1. Drugs are not the cause of come e.g. barbiturates. Neuromuscular blockade has been demonstrably reversed.

2. Hypothermia does not exist.

3. There is no endocrine or metabolic disturbance.

Testing for Brain Stem Death

Reflexes involving brain stem function.

1. No pupillary response to light.

2. No corneal reflex.

3. No vestibulo ocular reflex (Caloric test).

4. No doll's eye reflex.

5. No motor response to pain – in the Vth nerve distribution.

6. No gag reflex in response to suction through endotracheal tube or tracheostomy.

7. Apnoea persists despite a rise in $PaCO_2$ to greater than 50 mmHg (6.6kPa) against a background of a normal PaO_2.

Working Party Members

Dr M J Hardman	(Chairman)
Dr P J Fleming	
Professor M I Levene	a nominee of the British Association of Perinatal Medicine
Professor R J Robinson	a nominee of the British Paediatric Neurology Association

Terms of reference:-
The working Party was established by the Council of the British Paediatric Association on 4th March 1988 to consider the diagnosis of brain stem death in infants and children. Its terms of reference were to

"establish criteria for the diagnosis of brain stem death in infants and children which could be recommended for use by the medical profession as a whole".
The report was approved by Council of the BPA on 24th February 1989 and supported by the Council of the Royal College of Physicians of London on 8th June 1999.

Acknowledgement

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Appendix 5 Glossary of Terms

Auditory meatus	External opening of ear, “ear hole”
Apnoea	Absence of breathing
Auscultation	Listening – usually to heart or breathing sounds
Asystole	Absence of heart beat
Cerebrum	Conscious part of brain
Cranium	Skull
Cardiorespiratory Arrest	Combined cessation of heart beat and breathing
Cardiac	Related to the heart
Cardiac Autoresuscitation	Spontaneous restarting of the heart beat
Circulation	Blood flow around the body
Coma	Unconsciousness
CO_2	Carbon dioxide
CPAP	Continuous positive airway pressure, a factor in artificial ventilation
ECG	Electro-cardiogram, either a paper or electronic trace
EEG	Electro-encephalogram, brain wave recoding
E_tCO_2	End tidal carbon dioxide, the level at the end of a normal breath
F_iO_2	Inspired oxygen concentration
Gag reflex	Swallowing / choking reflex
Hypnotics	Sedative, sleep inducing drugs
Hypoxia	Lack of oxygen
Hypo-	Low
Hyper-	High
Hypocarbia	Low carbon dioxide concentration
Hypercarbia	High carbon dioxide concentration
Hypothermia	Low body temperature
Hyperthermia	High body temperature
Hyponatraemia	Low blood sodium concentration
Hypernatraemia	High blood sodium concentration
Hypokalaemia	Low blood potassium concentration
Hyperkalaemia	High blood potassium concentration

Hypoglycaemia	Low blood sugar concentration
Hyperglycaemia	High blood sugar concentration
ICS	Intensive Care Society
ICU	Intensive Care Unit
Intracranial Haemorrhage	Bleeding into the brain
KPa	Kilopascal, a unit of pressure measurement
Metabolic	To do with the energy supplies of the body
Muscle Relaxants	(Neuromuscular Blocking Drugs) Paralysing drugs
Mechanical ventilation	Connecting a patient to a breathing machine
Motor Function	Movement of parts of the body
Narcotics	Morphine like drugs with pain relieving and sedative properties
O_2	Oxygen
PaO_2	Partial pressure of oxygen
$PaCO_2$	Partial pressure of carbon dioxide
Palpation	Feeling for shapes or movement
Respiration	Breathing
SaO_2	Oxygen saturation, normally above 90%
Supraorbital	The area above the eye
Somatosensory	Nerve impulses generated by outside stimuli, e.g. touch, sound
Ventilatory / ventilation	To do with artificial breathing

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