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The donor doctor's dilemma: Observations on the recognition and management of brain death

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Professor Jennett first defines the term 'brain death' and the problems arising from a diagnosis of death, some the result of recent technological advances. The diagnosis is not necessarily connected with donor transplants, although in the popular mind this is still so. The criteria for establishing brain death and the sources of potential error in this diagnosis are outlined. The diagnosis of brain death can be made confidently, as is already common practice, and this should become standard good medical practice.

The increasing effectiveness and availability of modern resuscitation procedures is posing a problem for hospital doctors dealing with badly brain-damaged patients. The possibility of taking over ventilation mechanically for prolonged periods means that some patients whose breathing stops, and whose hearts would normally arrest soon afterwards, may continue to have satisfactory circulation for several hours, sometimes for a few days. Occasionally the cause of the respiratory failure is reversible, such as an overdose of depressant or relaxant drugs, or remediable compression of the brain stem, in which case ventilator treatment may prove life-saving and the patient make a good recovery. In most cases, however, there has been an irreversible cerebral catastrophe which would previously have been rapidly fatal, and this would have been accepted as inevitable by doctors, nurses and relatives alike. Now the doctor has to consider how long to persist with life-supporting measures when brain death is the outcome of resuscitation. Not only has he to make this decision, in the face of accepting his inability to save the patient and the need to explain this to the family, he may now find himself under pressure to try and secure organs from the patient for transplantation.

The occurrence of the condition we term 'brain death', and also the possibility of organ transplantation, are both the result of recent technological advances. It is understandable that traditional medical and social ethics have no ready answers to the questions which arise from such artefacts. However, brain death is a concept which is now increasingly recognized by doctors dealing with the critically ill. Whilst it is central to the problem of organ donation it has implications much wider than this and not only in medicine, for it raises philosophical and legislative issues. These cannot be sensibly discussed until doctors have defined brain death as a biological phenomenon. Until a considerable body of doctors and nurses are persuaded that brain death is a relatively common phenomenon, and one which they can confidently recognize on clinical grounds, it would be premature to expect society at large to feel comfortable about it. Attempts to achieve a better understanding of brain death have undoubtedly been hindered by its inevitable association with transplantation, and by press reports of incidents of proposed or attempted organ donation in circumstances which, from the few details available, suggest that doctors remain uncertain about the diagnosis of brain death. Because the decisions which follow such a diagnosis are usually irrevocable, it is natural that people should demand a high degree of certainty before reaching the conclusion that there is brain death. Fortunately it is a state which can be quite precisely defined. Nonetheless it is apparent that occasionally there has been confusion in the minds of doctors about distinguishing it from certain other related states. It should be emphasized that not all patients on ventilators with brain damage have brain death. Likewise only certain patients with extensive and irrecoverable brain damage have brain death. Moreover, only a proportion of patients with brain death are suitable as organ donors, although the problem of when to discontinue the ventilator has to be faced in all such patients. These three assertions will be examined in more detail once the phenomenon of brain death has been fully described.

Reasons for recognizing brain death

Brain death is the description applied to patients in whom respiration has stopped due to irrecoverable brain damage but in whom the circulation is still intact because artificial ventilation is being maintained. Even if all support is maintained progressive dissolution of the body continues and the heart will beat for only a few days at the most. If mechanical ventilation is not stopped until heart action spontaneously ceases the extremities may begin to decompose in the ward, whilst internal organs will be found in varying states of autolysis. Such indecisive management not only makes organ transplantation impossible but it deprives the patient of death with dignity, and it needlessly prolongs the distress of the family. There is

evidence also that the morale of nursing staff can be eroded if they are often required to continue expending effort and skill on patients whom everyone agrees cannot possibly benefit from their ministrations. Often other patients who could benefit from the facilities of an intensive care unit are denied admission because a 'brain-dead' patient is still being kept on the ventilator. There are therefore clear humanitarian reasons for withdrawing artificial ventilation once there is incontrovertible evidence of brain death.

Common causes of brain death

Head injury and spontaneous intracranial haemorrhage (either subarachnoid or intracerebral) can most readily produce the kind of sudden massive brain damage which, if resuscitation is vigorous, may be followed by brain death with a beating heart. The circumstances leading to head injury are usually obvious and the diagnosis is seldom in doubt. Most deaths caused by head injury occur within the first 24 hours, many of them in the first six hours. There is always concern that deterioration may be due to a secondary traumatic haematoma, evacuation of which might be life-saving. However, this diagnosis is usually considered only when there is good evidence that the patient, at some stage after the injury, showed signs of being much less severely brain damaged than he now appears. He may have spoken, even a few mumbled words being vital evidence; or he may have been restless or at least responding to painful stimuli. Most cases of brain death after head injury will be those which have seemed hopeless from the start, unresponsive, with fixed pupils from the time of first observation. Some may have had an intracranial haematoma diagnosed and evacuated, but have failed to improve – either because of underlying primary brain damage or because irreversible brain stem distortion had already occurred before decompression was carried out.

Spontaneous intracranial haemorrhage is usually a less certain diagnosis than head injury. However, if the patient has been seen to collapse, having been previously well, perhaps complaining of headache before becoming unconscious, and there are obvious signs such as hemiplegia, vitreous fundal haemorrhage, stiff neck, and bloody cerebrospinal fluid on lumbar puncture, the diagnosis is a reasonable one. In the case of subarachnoid haemorrhage there may have been a previous, less severe, haemorrhage which led to investigation by angiography, and the source of bleeding may be known to be an aneurysm or arteriovenous malformation. When such patients then suffer an overwhelming recurrent haemorrhage, often while awaiting operation in the neurosurgical unit, the diagnosis is absolutely certain. But when the first haemorrhage is catastrophic it is not usual to proceed to investigations, and that is also the case with head injuries which appear overwhelming from the outset. Not only is it known that surgery cannot help these patients, but facilities for investigation are largely restricted to neurosurgical units, where demand for admission almost everywhere greatly exceeds the beds available. Most such units deliberately endeavour not to admit patients with irrecoverable brain damage (the very patients who are potential donors); this policy is further encouraged by the development of intensive therapy units in most general hospitals, where such patients can now be adequately cared for in the first instance. If they improve after a time they may be secondarily transferred for further investigation.

This means that brain death is now a fairly common problem in general hospitals and these, rather than neurosurgical units, will increasingly become the source for donor organs. Understandably it was in neurosurgical units that the concept of brain death first emerged, because it was there that patients were commonly found in whom investigations, and often operative exploration also, had clearly established the extent of brain damage. The question now arises whether such a diagnosis can be reached without special investigations or the opinion of a neurosurgeon or neurologist, because these are available in only a small minority of hospitals. The answer is that in most instances the diagnosis can be made confidently, and such is already accepted practice, especially since acute receiving and intensive care became activities in which certain surgeons, physicians and anaesthetists specialize and develop their own expertise; this should include the recognition of overwhelming brain damage and of brain death. But there will always be cases where there is doubt, most often because the history is uncertain, such as when a patient is found unconscious in the street or at home. In such circumstances further opinions and perhaps investigations would likely be required, which could involve transfer to a special centre.

When cardiac arrest occurs in hospital, due to myocardial infarction or to an incident in the course of some procedure (commonly in the operating theatre), severe brain damage may result. It is unusual for the pattern of this damage to result in brain death – more often the selective vulnerability of the cerebral cortex results in neocortical necrosis. Such a patient will usually continue to breathe and to have active brain stem reflexes; if he survives he may be in a persistent vegetative state (see later).

Malignant brain tumours and uncontrolled intracranial infection only occasionally produce brain death; this is because deterioration is normally gradual and the diagnosis fully established, so that there is no case for resuscitation when breathing stops. In the other conditions described the institution of mechanical ventilation is by way of an initial response to an acutely developing crisis, because the therapeutic possibilities are at the time

unknown. It is when there is no response to resuscitation, or no remediable cause can be found for the crisis, that the clinician is left with the brain-dead patient on the ventilator. This is the price that must be paid for the successful resuscitation of the few patients who have a treatable lesion causing respiratory arrest.

Circumstances in which brain death may be considered

1) The patient has stopped breathing, is maintained on a ventilator and is not receiving relaxant drugs.

2) The diagnosis of irremediable brain damage has been established, as described above.

3) There is no suspicion that this state could be due to depressant substances, metabolic disturbances, or hypothermia. It is well known that the suspension of brain stem activity, which forms the basis of the criteria for establishing brain death described below, can be caused by depressant drugs or profound hypothermia. It is impractical to insist that prior chemical tests be undertaken to exclude all possible depressant drugs, because tests do not exist for some drugs and combinations of drugs which may be taken. In practice the exclusion of such depressant substances must rest on the history; wherever the circumstances are at all suspicious then the possibility of drugs contributing to the patient's state must be considered.

Once a patient becomes brain dead it is common for secondary hypothermia and metabolic imbalance to develop and it is the exclusion of these at the time of the development of the state of brain death that is important. In the majority of instances, as described above, a previously well patient is suddenly struck by a cerebral catastrophe, such as a head injury or intracranial haemorrhage, and these other causes can be reasonably excluded.

Criteria for establishing brain death

1) There should be no spontaneous respiration during five minutes' observation off the ventilator, oxygenation being maintained by a tracheal catheter delivering oxygen. During the five minutes the arterial P_{CO_2} will normally rise well above the threshold for stimulating the respiratory centre, the only exception being when the P_{CO_2} is already very low due to the patient's having been on a period of hyperventilation. The P_{aCO_2} should therefore be in excess of 36mm Hg before disconnecting the ventilator.

2) Brain stem reflexes should be absent.

a) The pupils should be fixed in response to light; background illumination should be subdued and a bright light used. Pupil size is irrelevant, but will normally be dilated.

b) The oculovestibular reflexes should be absent, that is, no eye movement *during* and for two minutes after the slow injection of 20ml of ice-cold water into the external auditory meatus, clear access to the drum having been established, on both sides.

c) There should be no corneal or gag reflex.

3) There should be no motor responses in the face in response to local painful stimuli.

It should be noted that spinal cord function may persist after brain death and that reflex movements of the limbs may therefore still occur.

The use of various laboratory investigations has been recommended from time to time during the evolution in recent years of criteria for establishing brain death. That most commonly recommended is the electroencephalogram, and, whilst this can be helpful in doubtful cases, it is not a necessary criterion. Electroencephalography is available in only a very limited number of hospitals and even in them it is rarely available on a 24-hour basis. Moreover the standard of recording required is of a very high order and it puts an undue degree of responsibility on both recordists and clinical neurophysiologists to ask them to declare beyond doubt that the record is isoelectric. If the clinical criteria listed above are elicited there is no need for an EEG and if any of them is in doubt then an EEG would not be sufficient evidence to overrule the clinical criteria. For that reason it is recommended that the EEG should not be used. Bilateral carotid angiography, in order to demonstrate the failure of circulation in the brain, has also been proposed. So have isotope measurements of the circulation by intravenous or intraarterial injection of gamma-emitting isotopes. Whilst the absence of circulation in the brain would certainly be evidence of brain death it is possible to have brain death with the circulation still intact, and these are therefore unhelpful investigations; they are also very limited in availability. The same applies to measurements of arteriovenous oxygen differences and quantitative measurements of cerebral blood flow.

Sources of error in the diagnosis of brain death

In view of sporadic reports of the apparently erroneous diagnosis of brain death, usually in connexion with transplantation, and of the concern properly expressed about how possible it is for mistakes to occur, it seems appropriate to consider possible sources of error.

1) Failure to limit the diagnosis to patients in whom the cause of brain damage and the clinical circumstances are both appropriate and failure to apply all the criteria of brain death in appropriate cases.

2) Failure to appreciate that reflex limb movements persist after brain death: uninformed bystanders may therefore wrongly report that the patient was 'still alive'.

3) Failure to distinguish between brain death and other forms of severe brain damage.

PERSISTENT VEGETATIVE STATE

The expression 'persistent vegetative state' refers to patients who remain unresponsive and speechless, but spontaneously breathing, for weeks or months after acute brain damage. Such patients never speak nor make any psychologically meaningful response, and the cerebral cortex is functionally inactive. The cortex itself may be destroyed, usually due to hypoxia or circulatory arrest; or it may be disconnected from brain stem arousal centres by extensive damage to white matter, usually due to head injury. Such patients are not recoverable and not sentient, but they breathe spontaneously and are not therefore brain dead.

LOCKED-IN SYNDROME

The term 'locked-in syndrome' is applied to patients with a ventral pontine lesion which leaves them incapable of any motor activity other than of the eyes and eyelids. These patients are fully conscious and may communicate by a code with their eye movements and they can breathe spontaneously.

PERIPHERAL PARALYSIS

Peripheral paralysis due to polyneuritis, poliomyelitis, or myasthenia may cause respiratory arrest and inability to move, associated with full consciousness, and such patients may survive long periods of artificial ventilation.

In all these states some or all of the brain-stem reflexes will be present; even if the possibility of brain death were mistakenly entertained it would soon become clear on applying the criteria for this diagnosis.

Recovery after hopeless prognosis

Occasionally it is asserted that a patient who was 'given up for dead' makes a good recovery. Such a situation is not infrequent when patients are in deep coma from hypothermia or depressant drugs; it sometimes happens after subarachnoid haemorrhage or head injury. Reports of this kind are seldom detailed and it seems likely that doctors' use of a figure of speech to describe a grave, but not in fact hopeless, condition is made the basis of a seemingly miraculous recovery. It has even been asserted that the possibility of being considered as a transplant donor may on occasion lead to a more assiduous search for remediable causes for coma, with the result that the potential donor has a better chance of recovery. It is unfair to cite anecdotal incidents of this kind as evidence that doctors cannot diagnose brain death, or that they might take organs from patients with potential for recovery. It is reasonable, in view of the constraints of time which successful transplantation requires, that an early warning may sometimes be given that a patient may possibly become a donor, if and when a remediable lesion has been excluded and he deteriorates further. Such cases should not be recorded as abortive attempts to take organs from unsuitable cases.

Who should make the diagnosis of brain death?

It has been emphasized that this diagnosis does not depend simply on the administration of a set of criteria or tests. It requires the judgment of a doctor who knows the whole clinical story, the likely cause of the brain damage, and the circumstances leading up to the present state. This can only be the doctor who is already looking after the patient, be he physician, surgeon or anaesthetist. There may be wisdom in having a second doctor consult with the first, to agree that there is no room for doubt, if transplantation is under consideration. Neither of these doctors need be a neurosurgeon or a neurologist, but one of them should have experience of brain death criteria; the MacLennan Committee's recommendation that one of the doctors should be qualified for more than five years seems a reasonable one. It seems likely that the decision to declare brain death and to discontinue ventilation would normally be made by a consultant after discussion with his junior staff, and there seems no reason to alter this natural arrangement.

It is to be hoped that the development of transplantation will not adversely affect the evolution of a rational and compassionate policy of discontinuing ventilation once brain death is diagnosed in a wide range of circumstances. The acceptance of this as good medical practice will, in the long run, make for less difficulty in the minority of cases in which the donation of organs in under consideration. It should not be forgotten that this has been the historical order in which these developments have occurred, and that it is the emergence of the phenomenon of brain death which makes the donation of certain organs possible: brain death has not been invented to respond to the needs of transplantation.

Further reading

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