ABC of Brain Stem Death

CHRISTOPHER PALLIS

PROGNOSTIC SIGNIFICANCE OF A DEAD BRAIN STEM

In section I a concept of human death was proposed: "the irreversible loss of the capacity for consciousness combined with the irreversible loss of the capacity to breathe." That a permanently non-functioning brain stem could provide the necessary and sufficient sub-stratum for such a state is a matter of anatomy and physiology. It might seem strange, at first sight, now to start discussing the prognosis of a corpse.

There is, however, merit in discovering whether brain stem death invariably heralds asystole—firstly, to establish a link between the present and the future; secondly, to reassure those who still believe that "real" death is the cessation of the heart beat and who would prefer a foot in both camps; finally, to answer critics who claim that we do not know the cardiac prognosis of the brain stem dead and even that diagnosing the condition leads to disconnecting patients from ventilators, and that a "fatal outcome" is therefore a self-fulfilling prophecy.

Ventilating to asystole

Papers written in the late 1960s leave no doubt that many patients fulfilling criteria of the Harvard type were still being ventilated for hours or days. Every neurological, neurosurgical, and intensive care unit did not immediately and without question accept the new criteria of death and start "switching off" all patients who met them. Questionnaires sent out in 1969 by the American Electroencephalography Society¹ to their own members (and to many neurologists) disclosed that at least 15% of the 405 neurologists who responded "insisted on traditional cardiorespiratory cessation for declaration of death." These physicians were presumably ventilating their comatose and apnoeic patients until the heart stopped. In the tense and controversy-ridden years that followed the Harvard report news of any "recoveries" would undoubtedly have leaked out and been seized on by the media, even if not reported to medical meetings or journals.

In Britain many units (our own included) continued to ventilate most such patients to an inexorable asystole. The problem was discussed informally several times. Not surprisingly little of this gruesome practice ever filtered through to the medical press, but imperceptibly, in the early 1970s, practice began to change. In 1970 the neurosurgical group at the Salpêtrière, in Paris, published an important study² showing that in nearly 70 patients with structural brain disease sustained apnoeic coma and absent stem reflexes always heralded asystole, despite the fullest possible ventilatory support. Moreover, these clinical signs nearly always preceded the development of an isoelectric electroencephalogram. A year later the Minnesota criteria were published,³ and we began to wonder about some of the things we were doing.

The publication of the UK code⁴ provided welcome guidance.

Confidence about withdrawing ventilation was gained only gradually. For instance, over 19 years the proportion of head-injured brain dead patients in Cambridge whose ventilators were electively stopped increased from 6% to 40%.⁵ It is still sometimes claimed that there has been no proper "controlled trial" to assess the prognostic value of clinical signs of brain stem death.⁶ It is difficult to envisage what the two groups of such a trial might consist of, but it is important to examine the damaging claim that doctors do not really know what happens when they persist in the macabre farce of ventilation after having diagnosed brain stem death. Over 1000 such cases have in fact been published, the biggest series being from three neurosurgical centres in the UK.⁵ These cases must comprise only a small minority of those observed over the years around the world. Asystole was the invariable outcome. The table seeks to bring together this scattered material.

Non-drugged patients diagnosed as brain dead by clinical criteria and maintained on ventilator

Series	Year	Patients accepted	Silent EEGs/ EEGs obtained	Survivors
Lindgren <i>et al</i> ⁷	1968	35	27/35	0
Becker <i>et al</i> ⁸	1970	15	6/6 + ?*	0
Gaches <i>et al</i> ²	1970	69	2/69	0
Mohandas and Chou ³	1971	25	3/9	0
Ingvar and Widen ⁹	1972	26	26/26	0
Ouaknine ¹⁰	1975	42	32/32	0
Walker and Molinari ¹¹	1975	141	130/141	0
Rappaport <i>et al</i> ¹²	1978	3	0/1	0
Ayim and Clark ¹³	1979	30	3/10	0
Hicks and Torda ¹⁴	1979	21	18/21	0
Ashwal and Schneider ¹⁵	1979	5	0/5	0
Kaste <i>et al</i> ¹⁶	1979	12	?/8*	0
Powner and Fromm ¹⁷	1979	182	164/182	0
Jennett <i>et al</i> ⁵	1981	326	67/70	0
Jørgensen ¹⁸	1981	70	Not stated*	0
Caronna and Plum ¹⁹	1981	34	1/10	0
		1036	473/611	0

*Excluded from totals.

The number of cases (from each reported series) accepted for analysis in this table is often smaller than the totals mentioned in the series themselves. Despite the development of asystole in all cases some of the patients did not, in my opinion, fulfil adequate clinical criteria of brain death, and some of the series include cases of drug intoxication. An additional 92 possible cases from two further series^{20 21} have not been included (although clinically brain stem dead and ventilated to asystole) because it was impossible to ascertain exactly what proportions of these cases were due to structural brain disease. The table deliberately underrepresents the relevant material.

How long in fact may cardiac action persist after a diagnosis of brain stem death? Published evidence suggests that in most cases asystole develops within days.^{5 7 22} Of the 63 patients diagnosed as brain dead in a large Danish series²² (and maintained on the ventilator) 29 developed asystole within 12 hours, 10 after 12-14 hours, 16 after 24-72 hours, and eight after 72-211 hours. Experience from Great Britain⁵ and elsewhere is in line with these observations.

"Surviving" brain stem death

It is not enough to list reports showing that patients with loss of brain stem function due to structural brain disease develop asystole despite ventilatory support. To satisfy those concerned with the cardiac prognosis of brain stem death it must also be established that no one with a dead brain stem has ever failed to develop asystole.

Discussions about brain death have been continuing for 20 years. Most have been highly technical and concerned with methods of diagnosis. Controversies about alleged survivors are of a different order. Even on superficial examination most such claims can be shown to have been based on fragmentary evidence or to be manifestly false. It is worth looking at some of the more recent allegations in the light of the UK code. Before doing so it is important to be clear about the relevant issue.

We are not arguing about whether undiagnosed patients ever recover after having been deeply unconscious; or about whether patients critically ill from intracranial disorder of known cause ever walk out of hospital; or even about whether patients with apnoeic coma associated with absent brain stem reflexes—for example, in the context of drug intoxication or metabolic upset, or shortly after cardiac arrest—ever survive. The answer in each case is that they may well do. Nor are we discussing the prognosis of patients in a chronic vegetative state or the outcome of other conditions in which there is residual brain stem function detectable clinically. Finally, we are not disputing that patients correctly diagnosed clinically as having a dead brain stem may retain, for a while, fragments of electroencephalographic activity or show reflex movement of spinal origin.

We are talking about patients with a credible diagnosis of irremediable, structural brain disease (such as head injury or intracranial haemorrhage) who—after having been on ventilators for several hours—are found to exhibit brain stem areflexia and persistent, properly documented apnoea. The effects of their primary condition must not have been complicated by drugs, shock, recent cardiac arrest, or a grossly abnormal metabolic state. This is the state defined by the UK code. It is rightly described as brain stem death, and it is not compatible with long-continued action of the heart.

Claims that patients have survived such a state (or that certain brain stem functions may recover in patients having met such criteria) still appear from time to time, usually in the public media. Before such claims can be accepted they must be screened systematically, and six basic questions should be asked.

(1) Is the case genuine? Or has it been conjured up for purposes of argument or debate?

(2) Is the case individually identifiable? Or can the patient be retrieved only piecemeal from a computer designed to store data about the evolution of particular constellations of clinical or electroencephalographic signs? Given the obvious international importance of such cases, have the details been

published in full, in a reputable and reasonably accessible journal? If not, is the relevant clinical information available to colleagues seeking to study the individual protocol?

(3) Was the patient in coma and on a ventilator? Was the primary diagnosis reasonably established as "structural brain damage"?

(4) Was the contributory role of drugs specifically excluded? Did the author know that one of the commonest causes of a reversible disturbance of brain stem function is drug intoxication?

(5) Was the timing of the examination for brain death appropriate (this is particularly relevant when the effects of the structural brain damage could have been aggravated by recent cardiac arrest, hypoxia, or gross hypotension)?

(6) Were the tests for apnoea adequate? How high did the Paco_2 rise? Did the survivor, at one stage, really show persistent apnoea in the presence of a Paco_2 of 6.65 kPa (50 mm Hg) or more? If the Paco_2 was not estimated was the patient at least given 5% CO_2 in oxygen to breathe before disconnection?

For those with the necessary patience it will prove both interesting and informative to submit some recent claims to such individual assessment. None of the five patients shown on the notorious BBC *Panorama* programme on brain death (13 October, 1980) came anywhere near to fulfilling these stringent requirements.²³

Dr Christopher Pallis, DM, FRCP, is reader emeritus in neurology, Royal Postgraduate Medical School, London.

- ¹ Silverman D, Masland RL, Saunders MG, Schwab RS. Irreversible coma associated with electrocerebral silence. *Neurology* 1970;**20**:525-33.
- ² Gaches J, Caliscan A, Findji F, et al. Contribution à l'étude du coma dépassé et de la mort cérébrale (étude de 71 cas). *Sem Hôp Paris* 1970;**46**:1487-97.
- ³ Mohandas A, Chou SN. Brain death. A clinical and pathological study. *J Neurosurg* 1971;**35**:211-8.
- ⁴ Conference of Medical Royal Colleges and their Faculties in the UK. Diagnosis of death. *Br Med J* 1976;ii:1187-8.
- ⁵ Jennett B, Gleave J, Wilson P. Brain death in three neurosurgical units. *Br Med J* 1981;**282**:533-9.
- ⁶ Evans DW. Questioning view of heart transplants. *The Times* 1982;Sep 13.
- ⁷ Lindgren S, Petersen I, Zwetnow N. Prediction of death in serious brain damage. *Acta Chir Scand* 1968;**134**:406-16.
- ⁸ Becker DP, Robert CM, Nelson JR, et al. An evaluation of the definition of cerebral death. *Neurology* 1970;**20**:459-62.
- ⁹ Ingvar DH, Widén L. Hjärndöd—Sammanfattning av ett symposium. *Läkartidningen* 1972;**69**:3804-14.
- ¹⁰ Ouaknine GE. Bedside procedures in the diagnosis of brain death. *Resuscitation* 1975;**4**:159-77.
- ¹¹ Walker AE, Molinari GF. Criteria of cerebral death. *Trans Am Neurol Assoc* 1975;**100**:29-35.
- ¹² Rappaport ZH, Brinker RA, Rovit RL. Evaluation of brain death by contrast-enhanced computerised cranial tomography. *Neurosurg* 1978;**2**:230-2.
- ¹³ Ayim EN, Clark GPM. Brain death: experience in an intensive care unit. *East Afr Med J* 1979;**56**:571-6.
- ¹⁴ Hicks RG, Torda TA. The vestibulo-ocular (caloric) reflex in the diagnosis of cerebral death. *Anaesth Intensive Care* 1979;**7**:169-73.
- ¹⁵ Ashwal S, Schneider S. Failure of electroencephalography to diagnose brain death in comatose children. *Ann Neurol* 1979;**6**:512-7.
- ¹⁶ Kaste M, Hillbom M, Palo J. Diagnosis and management of brain death. *Br Med J* 1979;ii:525-7.
- ¹⁷ Pownier DJ, Fromm GH. The electroencephalogram in the determination of brain death (letter). *N Engl J Med* 1979;**300**:502.
- ¹⁸ Jørgensen EO. Brain death: retrospective surveys. *Lancet* 1981;ii:378-9.
- ¹⁹ Caronna JJ, Plum F. In: Plum F, Posner JB, eds. *The diagnosis of stupor and coma*. 3rd ed (3rd reprint). Philadelphia: F A Davis, 1982.
- ²⁰ Ibe K. Clinical and pathophysiological aspects of intravital brain death. *Electroenceph Clin Neurophys* 1971;**30**:272.
- ²¹ Korein J, Maccario M. On the diagnosis of cerebral death: a prospective study of 55 patients to define irreversible coma. *Clin Electroenceph* 1971;**2**:178-99.
- ²² Jørgensen EO. Spinal man after brain death. *Acta Neurochirurg* 1973;**28**:259-73.
- ²³ Pallis C. Medicine and the media. *Br Med J* 1980;**281**:1029.