

OCCASIONAL PAPER

The transatlantic divide over brain death determination and the debate

Eelco F. M. Wijdicks

Division of Critical Care Neurology, Department of Neurology, Mayo Clinic, Rochester, MN, USA

Correspondence to: Eelco F. M. Wijdicks, MD, PhD.
Professor of Neurology,
College of Medicine,
Mayo Clinic,
200 First Street SW,
SW Rochester, MN 55905, USA
E-mail: wijde@mayo.edu

In 1976, the Royal College of Physicians published neurological criteria of death. The memorandum stated that—after preconditions and exclusion criteria were met—the absence of brainstem function, including apnoea testing, would suffice. In the USA, many experts felt that brain death could be only determined by demonstrating death of the entire brain. In the history of further refinement of UK and USA brain death criteria, one particular period stands out that would bring about an apparent transatlantic divide. On 13 October 1980, the British Broadcasting Corporation aired a programme entitled '*Transplants: Are the Donors Really Dead?*' Several United States experts not only disagreed with the United Kingdom criteria, but claimed that patients diagnosed with brain death using United Kingdom criteria could recover. The fallout of this television programme was substantial, as indicated by a media frenzy and a 6-month period of heated correspondence within *The Lancet* and *The British Medical Journal*. Members of the Parliament questioned the potential long-term effect on the public's trust in organ transplantation. Given the concerns raised, the British Broadcasting Corporation commissioned a second programme, which was broadcast on 19 February 1981 entitled '*A Question of Life or Death: The Brain Death Debate.*' Two panels debated the issues on the accuracy of the electroencephalogram and its place, the absolute need for assessing preconditions before an examination, the problems with recognition of toxins and the feasibility of doing a new prospective study in the United Kingdom, which would follow patients' examination assessed with United Kingdom criteria until cardiac standstill. The positions of the United States and United Kingdom remained diametrically opposed to each other. This article revisits this landmark moment and places it in a wider historical context. In the USA, the focus was not on the brainstem, and the definition of brain death became rapidly infused with terms such as whole brain death (all intracranial structures above the foramen magnum), cerebral death (all supratentorial structures) or higher brain death (cortical structures) virtually synonymous with persistent vegetative state. This review also identifies the fortitude of neurosurgeon Bryan Jennett and neurologist Christopher Pallis by introducing new corroborative data on the diagnosis of brain death and clarifying the United Kingdom position. Both understood that brainstem death was the infratentorial consequence of a supratentorial catastrophe. With the 1995 American Academy of Neurology practice parameters, the differences between the UK and USA brain death determination would become much less apparent.

Keywords: brain death; history; United Kingdom; electroencephalography**Abbreviations:** BBC = British Broadcasting Corporation

Introduction

Thirty-one years ago, the television audience in the UK watched an episode of the British Broadcasting Corporation (BBC) programme *Panorama* entitled, 'Transplants: Are the Donors Really Dead?' The programme explored whether the UK criteria were a sufficient basis on which to declare a patient brain dead and therefore dead. Interviews with US physicians revealed a telling disagreement with the UK criteria. The television programme further suggested that—using UK criteria—patients thought to be irreversibly brain dead could still improve. Patient examples further bolstered this claim.

This event until now has remained unexamined. This article revisits not only this television programme, but also its dramatic fallout. One of the intended consequences of the programme was to open up to the wider audience the disputes about brain death, and the programme started an intense debate between US and UK physicians. The programme led to the publication of editorials, followed by an explosion of letters to the editor in both *The Lancet* and *The British Medical Journal*. The first programme also led to a (BBC hosted) debate, the publication of a major study of patients with brainstem death by Jennett, and a classic work by Pallis: *ABC of Brainstem Death* (1983).

This period was a watershed moment in the history of development of brain death criteria. A transatlantic divide was clearly exposed by both television programmes, but it also created an academic storm in the UK and USA.

Methods

I obtained and closely reviewed the television programme 'Transplants: Are the Donors Really Dead?' through the BBC. I also obtained the partly preserved subsequent televised debate 'A Question of Life or Death: The Brain Death Debate', and reviewed the full transcript. This debate aired 4 months after the first programme, in an attempt to further clarify the issues raised by the *Panorama* programme.

I also researched all the published correspondence concerning this television programme. Most of it appeared in the *British Medical Journal* and *The Lancet*. I contacted Anne Moir, the BBC producer of the television programme 'Transplants: Are the Donors Really Dead?' In addition, I reviewed the memoir, on the history of *Panorama*, of the presenting reporter, Richard Lindley (Lindley, 2002) and contacted him by telephone to obtain further details.

I reviewed the 50-min television programme by dividing it up into 25 segments, and summarized and interpreted the commentary and interviews contained in this programme.

Panorama—'Transplants: are the donors really dead?'

Brain death criteria in the UK had been vetted, accepted and a Code of Practice had been published by the Conference of Medical Royal Colleges and their faculties in 1976 and 1979 (Department of Health and Social Security, 1979). What prompted the BBC to fully examine this topic, however, can be reasonably reconstructed. Moir, a producer on the BBC's flagship current

affairs television programme *Panorama* and an academic scientist, became interested in a potential controversy on brain death after reading a short notice in a journal for general practitioners in the UK entitled 'Americans question the British way of death' referring to a proceedings held in New York (Korein, 1978). Moir subsequently contacted neurologist Julius Korein who directed her to a number of other experts. Satisfied that there was a real and important issue for *Panorama* to tackle, Moir obtained the go-ahead from the editor of *Panorama* Roger Bolton, and with Lindley now assigned as reporter, began to explore the British way of diagnosing brain death. Moir contacted US neurologists and found that many did not agree with the UK position on the diagnosis of brain death. This prompted a lengthy review of the literature, planning of film interviews, and with the help of physicians, a search for illustrative cases with misjudgements (Anne Moir, personal communication).

At the time, transplantation was in flux, with re-emergence of cardiac transplantation after failed initial attempts in the late 1960s. While research for the programme was under way an editorial in *The Lancet* appeared named 'The renaissance of cardiac transplantation' (*Cardiac Transplantation*, 1980a) and a letter to the editor in response to this editorial appeared. The *Panorama* journalists followed up on the letter authored by cardiologist David Wainwright Evans and pulmonologist Claude Lum from the Cardiovascular Unit at Papworth Hospital in Cambridge, where in 1979 the first cardiac transplantation in the UK was done (Evans and Lum, 1980). They both suggested 'ethical alternatives to renal and cardiac transplantation' but also to 'temper enthusiasm for too hasty replacement of the natural fact of death by a legal fiction based on necessarily fallible medical opinion'. The *Panorama* programme was carefully prepared over several months. Producer Moir and reporter Lindley both recognized that they were stepping into a 'medical mine field' (Lindley, 2002).

The television programme aired on 13 October 1980, and began with an introduction by programme presenter David Dimbleby (Fig. 1), emphasizing the benefits of transplantation. He explained that 'to maintain confidence on the part of the donor's family requires that death is being defined in such a way that mistakes can be avoided'. 'When is a person really dead? It is an obviously vital question to answer'. Dimbleby suggested that British methods defining death might need to be re-examined, particularly when compared with those of other countries.

One major overriding theme of the television programme was that UK physicians mostly looked at the brainstem only. In a crucial moment, in the programme, this approach is explained:

Richard Lindley: 'Before doctors can be certain the brain is not just temporarily out of action but really is dead, how much of the brain do they actually examine? Well, the answer in Britain is very little indeed. Our doctors simply do not measure at all what you could call the thinking parts of the brain (these bits here) to decide that the entire brain is dead so that they can switch off your respirator and if you are a donor take your organs out. British doctors look just at one small part of the brain, the brainstem, why?' (Fig. 2)



Figure 1 Opening shot of the BBC programme, with David Dimbleby presenting.



Figure 2 Richard Lindley showing the brainstem (see text for explanation).

After this explanation, neurosurgeon Bryan Jennett is asked to respond to this question.

Jennett: 'Because the confirmation of brain death is only entered into once we know the rest of the brain is out of action and we know that from knowing what the diagnosis is, we are not being presented blind with a patient. We know that we have operated on this patient or has had a head injury or has had a brain haemorrhage. That is all out of the way. We know what has happened. We are then down to the final details. That is, that part of the brain having gone, is the brainstem also gone?'

The BBC programme continued to tackle other issues on brain death determination and organ transplantation. The television programme's contents and details on all the cases are summarized in Table 1. First, the programme showed that several US physicians did not agree with the UK criteria. Investigators of a large prospective study involving major medical centres in the USA (the National Institute of Neurological Disorders and Stroke Collaborative Study) had found that patients who were diagnosed as brain dead with UK criteria could recover. Neurologist Korein mentioned 165 patients who apparently fulfilled the UK criteria and claimed that 14 had survived: 12 were intoxications, one

Table 1 Description of the *Panorama* television programme, 'Transplants: Are the Donors Really Dead?'

| Segment | Description of segment | Interpretation and points made |
|---------|---|--|
| 1 | Brief introduction of the story of a patient in the USA diagnosed with brain death who is alive because the transplant surgeon saw movement. | Transplant surgeon finds patient alive. Ironically, the transplant surgeon may be your last hope. |
| 2 | Section showing the British Transplantation Olympics with overjoyed teenagers. Also showing government effort to donate organs. | Transplantation saves lives. However, when people are asked to donate organs 'after my death', what does death mean? |
| 3 | Section showing UK police recruits how to recognize a corpse and allowing them to touch it. | Physicians will not make a mistake seeing a corpse and have the time to make that assessment, but a corpse is useless as a transplant donor. |
| 4 | Section showing transplant surgeon (Dr Robert Sells) signing the medical record of a brain dead patient agreeing with the other physicians. The narrator suggests the transplant surgeon is in a hurry to take the organs, because the heart will soon stop. | There is a rush to take organs, because there is little time to keep them in top condition. |
| 5 | Section showing that not all physicians agree with the UK criteria. A letter to the editor in <i>The Lancet</i> arguing against brain death is shown, as is an interview with US neurologist Selby O'Reilly, who says that declaring these patients dead is a judgement and agrees we may be killing dying patients. | Despite the statement by the Royal College of Physicians that brain death is an accepted fact, not all physicians in the UK (Evans and Lum) and USA (O'Reilly) agree these patients are dead. |
| 6 | Section presenting the first case. The patient's wife describes being told that the neurologist has declared her husband brain dead. But, he was purple and thrashing about and when she suggested that 'he does not look dead to me,' she was told it was just reflexes. The patient himself describes that he could hear the surgeon speak. According to the patient, the surgeon described he saw the patient's 'Adams apple' move and his eye flicker. The patient overheard 'This body is not for us.' | First case from the USA. Doctors make mistakes but also ignore signs to the contrary, even if pointed out by family members. The narrator claims 'that the brain was never dead just temporarily not working'. |
| 7 | Section showing Richard Lindley dismantling a model of the brain, leaving out the hemispheres ('the thinking parts') and showing a tiny part of the brain, the brainstem (Fig. 2). | Do we really examine the brain or just parts? British doctors just look at one small part of the brain and only the brainstem. |
| 8 | Section where Jennett explains that we know the diagnosis and we know the 'brain is out of action' and 'we are down to the final details'. | The loss of brainstem function is part of the entire brain destruction, not a single part, and the last part to go. |
| 9 | Section describing parts of the clinical examination. Two independent doctors are needed. | The narrator claims the UK guidelines do not require a 'brain specialist'. |
| 10 | Section showing the organ procurement. Narrator mentions that anaesthesiologists routinely give a paralyzing agent to make sure they do not move, something that 'inexperienced nurses may find upsetting'. | Do all surgeons really feel the patients are dead? After this 'lethal operation', we better be sure. Is there any evidence doctors can make a mistake? |
| 11 | Section showing 'alarming discoveries in a new US study'. The US Collaborative Study is explained showing major institutions looking at survival of apnoeic patients with no cephalic reflexes. Interview with Dr Gaetano Molinari suggests we cannot be 100% sure and cannot prove it at autopsy. | One of the US Collaborative Study's conclusions is that the autopsy will never confirm whether the physician was right. The narrator suggests that if you cannot prove it, the criteria should never fail. |
| 12 | Section with interviews with Drs Gaetano Molinari and Earl Walker claiming that cephalic reflexes have come back after 30 h and clinical criteria may not be adequate. Molinari also states he feels compelled to use every test including 'some very sensitive ones' to make that one-time diagnosis. | Another conclusion of the US Collaborative Study is that several days must elapse to safely say the brain is dead. US physicians seem more inclined to do more tests to be certain. |
| 13 | Section interviewing neurologist Dr Donald Bennett claiming that half of the patients with no cephalic reflexes had EEG activity and he would not switch off the ventilator if EEG activity was found. | Perhaps an EEG is helpful, but UK physicians do not seem to care about it too much. |
| 14 | Section titled 'The corpse that was still conscious.' A case is presented of a man in the USA who was considered brain dead, but was paralyzed and apnoeic as a result of a neuromuscular blocking agent and survived. The neurologist (Ronald Tyson) was convinced the patient had a destroyed brain and could have had his respirator switched off, but an EEG found normal activity. | The second case from the USA. An extra test (EEG) can be helpful and make all the difference. The narrator suggests that in UK only 1 in 10 hospitals have EEG facilities and UK physicians deny themselves a safeguard. |

(continued)

Table 1 Continued

| Segment | Description of segment | Interpretation and points made |
|---------|---|---|
| 15 | Section with Jennett claims EEG is unnecessary and unreliable. It is also quite difficult to exclude all the artefacts. The EEG is much less important than the straightforward clinical examination. But when UK neurologist Dr Ronald Paul is asked, he would under no circumstances consider the patient dead if there was EEG activity. | There is a disagreement among neurologists and neurosurgeons whether an EEG is needed. But other countries including all US states require it. |
| 16 | Section on miracle recovery of a premature infant. A 'miracle baby' is presented with a flat EEG who survived and is in fact performing above average. The conviction of neonatologist Dr Paul Byrne was that the baby was not dead and he did not allow his respirator to be switched off. Dr Byrne states with the current criteria that we cannot be certain whether patients are dead or alive, and taking out a heart we may kill them. | The third case from the USA. It is claimed that doctors agree that they are more likely to be wrong in children. No age limit has been defined in the UK Code of Practice while transplants go on in children (1–14 years). |
| 17 | Section with neurologist Dr Fred Plum, who states that a severe overdose may just look like brain death when no electrical activity is found. Plum was called to see if they should give up on a mysterious patient after 72 h. The physicians were very reluctant to accept his suggestion that it could be intoxication. It turned out to be intoxication and the patient fully recovered and later she thanked Dr Plum for her life. | Again intoxications may fool you and the history may not be reliable. You cannot safely rely on the clinical history. |
| 18 | Section on a young female with a known drug overdose was pronounced dead on arrival by a police officer. She could hear him saying she was gone. | The fourth case from the USA. Again, drugs can mimic death and even when intoxicated you may be pronounced dead. Errors abound. |
| 19 | Section on the US Collaborative Study. Dr Earl Walker presents 26 cases where drug levels were found and could have contributed to the demise of the patient. Yet, the lives were ended because the respirators were switched off. The study suggests that doctors diagnosed patients as brain dead without knowing they had taken drugs. Dr Gaetano Molinari again stresses that it is often difficult to tell if some drugs might be playing some role and the EEGs may be flat due to the drugs taken. | Even though the EEG can be flat the patient may be not dead. Even physicians may not recognize drug intoxications. Even US physicians in the best institutions may not recognize it. |
| 20 | Section interviewing Dr Julius Korein who presents 165 patients who apparently fulfilled the UK criteria and claimed that 14 had survived, 12 were intoxications, but one was a stroke and the other an anoxic injury. He suggests to the British to study 100 patients to cardiac standstill with full resuscitative measures and see how many survive. | The first claim that patients diagnosed with brain death using UK criteria can recover. It could be self-fulfilling 'You pronounce someone dead and they are dead'. |
| 21 | Section with Dr Sells and Jennett who are asked if there is such a study as the US Collaborative Study in the UK. | Dr Sells is not aware of a study in the UK similar as to the US Collaborative Study, but believes there is a large amount of evidence known to neurosurgeons. Jennett's answer: 'we have done no such study'. |
| 22 | Section on brain death determination in Norway. In Norway when a transplant is considered, a cerebral angiogram is done. When no blood is seen for over an hour the patient is dead. Neurosurgeon Dr Ragnar Nesbakken feels that these tough criteria exclude errors. | Some physicians feel more tests provide more certainty. |
| 23 | Section on a demand for organ donation. There is a kidney shortage in the UK. | Perhaps doctors may not be certain and thus there may be a shortage. |
| 24 | Robert Sells, a transplant surgeon, is asked if he has been called to see a patient that turned out not to be brain dead and admits he has seen very few cases who were 'not in that category'. | Even if transplant surgeons are asked to see a patient before procurement they may find the patient may not be brain dead |
| 25 | Section with final exchange with Bryan Jennett asking if he is sure—he is (see text). Curtain falls, end of programme. Music of Francis Lai (Aujourd'hui C'est Toi). | Contrary to evidence presented, the main proponent of brain death is as certain as he can be. |

was a stroke, and one was an anoxic injury. Second, US physicians seem inclined to do more clinical and laboratory testing to be certain of brain death. An extra test such as EEG can be helpful and make all the difference. However, the programme suggested that in the UK, only 1 in 10 hospitals have EEG facilities, and as a result UK physicians deny themselves a safeguard. A case was presented of a male in the USA, who was considered brain dead, but was paralyzed and apnoeic as a result of neuromuscular blocking agent and survived. An EEG found the patient conscious. Third, EEG may be an important diagnostic test, since when used in a clinical study, activity may be found in 50% of patients with no brainstem function, and therefore cannot be considered dead. Fourth, the programme showed that clinical history is unreliable and cases with intoxications may be difficult to recognize with certainty. The US Collaborative Study implied that even physicians in renowned medical centres were surprised to find evidence of intoxications in patients presenting to them in an apnoeic coma. Four illustrative patients, all from the USA, were shown with dramatic recoveries.

Finally, it was suggested that organ procurement in the UK might be lower than elsewhere because perhaps UK physicians did not feel as confident about diagnosing brain death. Still, Jennett, the BBC-identified UK expert on brain death, was not persuaded, contrary to the evidence provided and in the absence of a similar study in the UK. The television programme ended dramatically with a final exchange with Jennett. Jennett was asked in multiple different ways if he was certain about diagnosing brain death.

Lindley: 'Are you saying using our criteria that we are never going to remove organs from a transplant donor before he is dead?'

Jennett: 'That is my belief.'

Lindley: 'No question in your mind? No possibility of error?'

Jennett: 'If I thought there was, I would not be doing it.'

Lindley: 'Hundred per cent accurate?'

Jennett: 'That is right.'

The fallout and correspondence in the leading British medical journals

The television programme created a controversy; and a week after the programme aired, editorials in *The Lancet* and *The British Medical Journal* appeared (Anonymous, 1980a, b). The editorial in the *British Medical Journal* was most notable for its utter feeling of discontent and profound anger at times. The editorial author called the programme a 'disgrace' and could only conclude that it was produced to cause 'maximal disquiet'. It specifically noted that 'the Panorama team produced no evidence – not even a hint – that the British system produced anything like the catalogue of disasters they filmed in the United States'. The editorial in *The Lancet* seemed more restrained and called for a study similar to the US Collaborative Study. This editorial also notably critiqued the US Collaborative Study and stated that '...some

important information was not provided: this study included all patients over 1-year-old who had been cerebrally unresponsive and without respiration for 15 minutes, irrespective of its cause. In other words there is no reason to suppose that the diagnosis of brain death would ever been contemplated in many'. The editorial, however, concluded that 'The Royal Colleges should set about organizing such a study at once. Meanwhile there will be pressure to do EEGs in many potential transplant donors before death is declared' (Anonymous, 1980b).

There were 29 letters to the editor in *The Lancet* and 35 letters to the editor to the *British Medical Journal* from October 1980 to April 1981 (Supplementary material).

The content of these letters included anger with medical misrepresentation, proof that doctors say foolish things on television, allegations of problematic editing [including letters from participants clarifying their position and complaining that their comments had been taken out of context (transplant surgeon Robert Sells, neurologist Fred Plum and neurosurgeon Jennett)] arguments for and against EEGs, suggestions for more tests, calls for a UK study, critique of the UK Code of Practice, pitfalls of clinical examination and suggestions that nurses and lay people were tearing up donor cards. A few months later, a letter to the editor in *The Lancet* addressed the impact on kidney donation and claimed a further decline after the BBC programme, although numbers of transplants were declining in the months before the programme (Bradley and Brooman, 1980).

The *Panorama* team had recognized early on that to question the British way of diagnosing brain death might deter some donors, but as Lindley later wrote:

The team were encouraged to discover that in Denmark, where the criteria for brain death included more stringent tests than anywhere else the proportion of people willing to become donors in the event of their death was the highest in the world. If *Panorama* did expose weaknesses in the British way of brain death, perhaps it would bring about changes to the rules which would ultimately increase the number of potential donors (Lindley, 2002).

The fallout in the media was substantial with screaming headlines in some papers (e.g. 'Are some patients being done in? British show on brain death angers doctors, upsets public'; 'television shock of "live" donor'; Pallis, 1983). Television critics were more complimentary in their comments. The *Daily Telegraph* reported 'it was hard hitting, thoroughly researched, totally convincing piece of investigation, which only the very insensitive or the very confident could laugh off' (Lindley, 2002).

However, Members of Parliament questioned the potential long-term effect on the public's trust in organ transplantation. There were calls to 'right this disgraceful wrong' (News and Notes, 1980b). Demands for an apology were rejected by the BBC but given the concerns raised and the public interest aroused, the BBC commissioned a second programme. Maintaining its editorial independence as a public service broadcaster, it nevertheless gave physicians critical of the first programme a producer and film crew to make their own 15 min film with which to justify their position in whatever way they wished. Moir made a new 10 min

film restating the doubts aired in the original *Panorama*. To give further assurance of the BBC's independence, the *Panorama* editor Bolton, the reporter Lindley and the programme's regular presenter Dimbleby played no part in the second programme.

The second BBC programme was broadcast on 19 February 1981 and was entitled 'A Question of Life or Death: The Brain Death Debate.' Two panels made up of four physicians each, one nominated by the Conference of Medical Royal Colleges and their faculties led by Jennett and Pallis, and the other panel led by Ronald Paul debated the issues. The programme was aired late at night and ended close to midnight, when 4 million people were still watching (Lindley, 2002).

The debate was chaired by Sir Ludovic Kennedy and panel members sat at two tables facing each other (one table with Jennett, neurosurgeon; Lillian Hanson, intensivist; Pallis, neurologist; Bruce MacGillivray, neurologist and neurophysiologist; and another table with Paul, neurophysiologist; John Hughes, neurologist; John Gumpert, neurologist and neurophysiologist; Ragnar Nesbakken, neurosurgeon). The programme included films on the examination, a long discussion on the accuracy of the EEG and its place, the absolute need for assessing preconditions before an examination, and the feasibility—unethical and distressing according to Jennett—of doing a new prospective study that followed patients until cardiac standstill and effectively stopping organ donation for the time of the study. Pallis repeatedly emphasized that the preconditions needed to be met.

There were many exchanges between the panel members, but one was particularly illustrative of the dispute. The question raised was: 'How do neurologists interpret EEG activity despite brainstem areflexia and apnoea, and does that not simply mean that the patient is not dead?'

Hughes: 'On that, I wonder if I could pick up on the point that our moderator discussed early on: and that is, Dr Pallis, do you think that you can prove that there is no awareness in a patient who can continue to show EEG activity in view of the fact that you admit that therefore his cerebrum is alive. Can you prove that there is no possibility of some awareness?'

MacGillivray: 'I could answer that. I think you can't prove it nor can you disprove it. The fact of the matter is the patient is, or the person is, in coma. And they have been in coma all along. Now, you would have to say that they are not in coma, or that they have something else which is—which is functioning.'

Hughes: 'Well, of course, coma is a term that applies to many different states, from very mild coma to a deep one. And we are talking about how much here. How much—and my point is—that as long as the anterior, reticular formation in the thalamus continues to be alive, and since the reticular formation is that part of the brain dealing with awareness, then isn't it conceivable to you that there can be some degree of awareness. Even though it's the brain stem that deals primarily with this function?'

MacGillivray: 'Well, absolutely not. You see, you talk about the profundity of the coma. How deep it is. We are dealing with patients who are at death's door, as it were. We're not dealing with a person who just lapses into unconsciousness. We're dealing with a situation that we've observed over several days, or

hours, or whatever, we know the clinical diagnosis, we know that we are dealing with a profound coma due to a structural lesion or damage in the brain, so it's not the same as coma say from lack of glucose or something of that sort—it's a different pattern. We, the whole Code demands that this is a precondition of your considering this...'

Paul also mentioned the suggestion of safeguards in children, but Pallis countered that 'physiologically they are no different and the argument is visceral and not scientific'.

In addition, when asked by Jennett whether anyone had seen a patient survive after meeting the UK criteria, much to the surprise of the opposite panellists, Paul reported having seen two patients with brainstem areflexia surviving during his 8-year retrospective series of 210 coma cases.

The programme did not appear to put controversies to rest and the intransigent stance of both panels was evident. The debate was technical and specialized and may not have had the effect of changing public opinion. But, during this debate, it was mentioned that the alleged decline of transplant donor after the *Panorama* programme had reversed itself or perhaps never was. The US and UK positions seemed diametrically opposed to each other—at least with only one US representative present. In order to obtain further expert opinion, in a film shown, Jennett asked Plum about the US interpretation of UK criteria:

Jennett: 'Do you think the US will ever adopt the UK criteria?'
Plum: 'I think we're moving closer together. It's difficult to judge local circumstances in a very big country in which practices vary widely from region to region, city to city and even hospital to hospital as to the way certain kinds of patients are treated—all with good intent—that must be said when one looks closely, usually without any very great difference in outcome. Whether we will adopt a national code as clean as the one you have, I don't know. Certainly, the present code of the American Neurological Association, which makes the obtaining of an EEG a permissive step, to all intents and purposes, is the British code.'

Jennett: 'Do you think the UK criteria are sufficient?'

Plum: 'Yes.'

Jennett: 'Have you ever found any patient diagnosed as brain dead by criteria equivalent to the UK criteria who had recovered?'

Plum: 'No.'

The correspondence in the *British Medical Journal* and *The Lancet* picked up briefly again after this second BBC programme. An editorial in the *The Lancet* praised Jennett's report on 609 patients (see below) who satisfied the UK criteria, emphasizing that no cases had recovered using UK criteria and concluded that 'If the British criteria are reliable and never lead to the diagnosis of death in a patient who might survive, then an isoelectric EEG record cannot increase their reliability'. The correspondence again focused on the scrupulous adherence to the UK criteria. Neurologist Erik Jorgensen from Denmark (in contrast to the Norwegian neurosurgeon panellist Nesbakken), argued that in his experience tests such as EEG and cerebral flow studies were

not necessary, and he found no added value in them (Jorgensen, 1981). *The Lancet* received several letters asking for publication of the two surviving cases mentioned by Paul, and he was repeatedly challenged in letters by Jennett and Pallis to present details. His claim was later withdrawn in a letter to the editor (Paul, 1981).

The Jennett and Pallis rebuttal

Pallis, at the time a Reader in Neurology at the Royal Postgraduate Medical School, presented clear evidence in another editorial that none of these US cases would represent brain death and concluded: 'It is a sad comment on the atrophy of clinical skills and on the drift to instrumental medicine so prevalent in parts of the United States today that the vindication of the electroencephalogram EEG was based on cases so poorly assessed from the clinical point of view'.

Jennett further analysed the essence of the BBC critique of the UK criteria in a comprehensive editorial (Jennett, 1981).

In the correspondence in *The Lancet* and *The British Medical Journal*, Pallis and Jennett concentrated quickly on the US Collaborative Study. This study entered 503 patients who were apnoeic and had no cephalic reflexes (seen as soon as 15 min after presentation) and were prospectively followed for several days until death or recovery. Pallis argued that the US Collaborative Study suffered from a high percentage of insufficient examinations, virtually no apnoea test using the CO₂ challenge—a required test in the UK—and a high percentage of patients with intoxications. The US Collaborative Study was cited as the only US prospective study that looked into brain death, but only a fraction of those patients probably met the criteria or, in Pallis' opinion, 'the Collaborative Study should perhaps be allowed to suffer a conventional death without further attempts at resuscitation. Its conclusions should certainly no longer be used as evidence against the British Code of Practice' (Pallis and MacGillivray, 1981).

Jennett's reading of the US Collaborative Study—embarrassing though it was for those concerned—was best summarized in his remarks during the debate: 'It is a ridiculously sloppy document and most neurologists in the United States think that. It was refused publication initially in the leading neurology journal in the United States'.

Korein's understanding of brain death—his preferred term was cerebral death—was death of all supratentorial structures with less emphasis on the brainstem. A major problem was to understand Korein's claim of the recovery of two patients diagnosed using the UK criteria (mentioned in the first programme). Initially, in a letter to the editor, Korein reiterated the two patients who on initial examination were comatose, apnoeic and 'cerebrally unresponsive with absent cephalic reflexes' but subsequently survived. In further correspondence with Pallis, it appeared that these two cases, who recovered within 12 h, were incompletely evaluated with absent metabolic and toxicological evaluation and no apnoea tests. One case of 'basilar artery occlusion' with no brainstem reflexes recovered completely, and such a recovery in a usually devastating stroke casted particular doubt, but no further details were presented (Korein, 1980; Pallis, 1980).

Soon after the second programme, Jennett published two papers (Jennett and Hessett, 1981; Jennett *et al.*, 1981). One of these papers presented 609 patients in three neurosurgical intensive care units in Cambridge, Glasgow and Swansea (Pallis, 1980). In 476 patients with a clinical diagnosis of brain death, ventilatory support was continued until the heart stopped, usually within days (median 30–40 h; <24 h in 38%; <49 h in 34%). Jennett also validated brain death by looking at 1003 surviving patients with traumatic head injury and found that none had a combination of apnoea, fixed pupils, absent eye movements and other unresponsiveness (Jennett *et al.*, 1981). Jennett's second article documented that organ donations stayed roughly the same, with declines in some areas and increases in others. Jennett also cited a survey that showed no decline in organ donation rates (Jennett and Hessett, 1981). In 1981, there was some decline in numbers of organ transplants, but linking these events with commonly fluctuating numbers of organ transplantations remain impossible to prove, and between 1979 and 1990 the number of organ donors did increase from 458 to 923 (data provided by UK Transplant).

In order to bring further clarity, Pallis was asked by Stephan Locke, the editor of the *British Medical Journal*, to write a series of papers that was later bundled and became the '*ABC of Brainstem Death*'.

Lessons learned and afterword

The development of brain death criteria—both in the UK and USA—has been well chronicled (Pallis, 1983; Wijdicks, 2003, 2011).

Once accepted as a neurological definition of death, medical interventions are now futile and unnecessary. The diagnosis of brain death is closely linked to organ donation and today, after the family or proxy consents, the majority of patients declared as brain dead become organ donors. There will always be conflicting views, but in the medical community, there is little question about the meaning of brain death. However, particularly in the 1960–80s, this truism of death after being diagnosed brain dead was open to serious contradiction and debate. In 1976, the Royal College of Physicians stated that brain death is an accepted fact and, with great insight, provided a template on how to diagnose brain death and how to avoid mistakes.

The BBC became interested in presenting to the audience the doubts of distinguished experts in the USA (and in some other countries) as to whether it was sufficient to look just at brainstem reflexes before deciding that someone was dead. The television programme illustrated the potential for errors in four misdiagnosed patients. The televised cases depicted in the Panorama programme suggested that intoxications could not only mimic brain death, but physicians may not recognize that, particularly, in a hurried atmosphere with transplant surgeons waiting. The programme also put forward the lack of EEG capabilities in the UK and asked whether the EEG should be a necessary component of the examination, as it usually was in the USA. The BBC programme also surmised that a kidney shortage in the UK could potentially be explained by UK physicians being hampered by diagnostic uncertainty. More clarity

or more comprehensive testing on possible donors could potentially increase the number of donors. Both BBC programmes comprehensively summarized the UK and US positions at the time.

Review of this episode has substantial historical value. The differences in the opinions became quite clear in the second BBC programme. The position Jennett's panel all along was that brainstem loss follows axiomatically after catastrophic hemisphere injury. The position of Paul's panel was that persistent EEG activity could not fit with death of the brain irrespective of the neurological findings. Loss of brainstem function alone could resemble the sleep state as described in 'cerveau isolé' (intercollecular transection preparation resulting in sleep-like state with cortical spindle bursts). It was argued that such a comparison, however, would ignore the common diencephalic destruction in patients progressing to brain death.

Moreover, there were claims of patients improving with no brainstem reflexes and apnoea. Details of some patients remained unknown, confounders were likely and apnoea tests were typically not performed. One claim that such patients existed in the UK was later officially withdrawn. In a letter, 16 months after being a participant in the debate, Hughes again questioned the certainty of brainstem death and claimed that there were 48 patients from the US Collaborative Study with absence of 10 brainstem reflexes, but with EEG activity, who recovered within 3–5 days; and he cited three patients from another medical centre. Details about these patients entered in the US Collaborative Study have remained unknown (Hughes, 1982). Pallis noted in 1990 'to date not a single case seems to have been recorded, in a reputable and widely accessible journal, of a patient with well documented structural brain damage (from trauma or intracranial haemorrhage, for instance) who recovered brainstem function after fulfilling properly applied clinical criteria of brainstem death' (Pallis, 1990).

The entire episode exposes a major difference of opinion with UK and US physicians in a heated debate. That being so, on the whole, this review identifies the fortitude and insights of neurosurgeon Dr Jennett and neurologist Dr Pallis in clarifying brain death criteria by systematically responding to inaccuracies in letters to the editor, by introducing new corroborative data (Jennett said in the programme, 'The brain death debate', that the 'doubters needed to know what we already knew'), and by publishing a cohort of patients that further clarified the clinical criteria of brain death determination.

The major debate further explained the UK position on brainstem death and helped to clarify why the UK and US positions were semantically different but clinically synonymous. The emerging image of brainstem death is that it is part of unsurvivable brain damage, and without exception it predicts cessation of heart beat and decreasing hypotension among other manifestations. Brainstem death is a catastrophic hemispheric lesion, ending with loss of all brainstem function. The formulation of brainstem death is largely pragmatic and accepts the centrality of the brainstem. No patient recovers after all reflexes are absent, confounders have been excluded, cause is established and apnoea is proven. All lesions of the brainstem are secondary. Primary lesions of the brainstem rarely, if ever, result in loss of all brainstem function and if they do, the effects of the lesion are rarely isolated.

So what happened in the UK after this incident? Robson—honorary secretary of the Conference of Medical Royal Colleges and their faculties—reported in a letter to the *British Medical Journal* that at the meeting in July 1981, it was decided that major changes were not needed but recommended appropriate safeguards should be observed (Robson, 1981). There was little more discussion in the UK with the 1995 revision specifically mentioning that: (i) certain endocrinological abnormalities may be a consequence of brain death rather than a confounder or potential mimicker; (ii) neurophysiological or imaging investigations have no place in the criteria and should have no role in the diagnostic requirements; and (iii) warned of overlapping neurological syndromes associated with critical illness (*Journal of the Royal College of Physicians of London*, 1995). A working group of the British Paediatric Association published guidelines much later, in 1991, and concluded that the brain death criteria in children over the age of 2 months should be the same as those of adults (British Paediatric Association, 1991). The main criteria have remained unchanged, but the Code of Practice has been regularly updated, most recently in 2008 (Academy of Medical Royal Colleges, 2008).

What happened in the USA? The *Panorama* team set out to discover why the UK way of diagnosing brain death differed from the way it was typically done in the USA. Curiously, the emphasis on irreversible brainstem injury was first proposed by US neurosurgeons Drs Mohandas and Choi. In their 1971 study, clinical irreversibility and autolysis of the brainstem at autopsy were associated with EEG activity implicitly questioning the relevance of the EEG (Mohandas, 1971). In 1977, the American Neurological Association stated that the EEG was 'a valuable confirmatory indicator of brain death and its use is strongly recommended' (American Neurologic Association, 1977). Neurosurgeon Black, in an important overview of the development of brain death criteria, concluded in 1978: 'At present there is no official consensus on the best criteria for the diagnosis of brain death in the United States' (Black, 1978). However, in an editorial Black wrote about the UK criteria: 'this approach may not allow for technologic progress in such areas as blood flow determination. It has an arbitrary quality that may be distasteful to some. Perhaps more importantly, it has been difficult to achieve similar consensus in the United States' (Black, 1980). The practice of US neurologists at the time was less well known, but the leading text on coma by Plum and Posner (1980) questioned whether an experienced clinician needs an EEG, and expressed that EEG was helpful ('... provides objective, verifiable support to clinical appraisals...') when transplantation or legal proceedings were anticipated. Plum and Posner further de-emphasized the EEG in a revision in the third printing in 1982: 'We have recently revised our criteria and have placed the EEG in the category of a confirmatory test in the diagnosis of brain death'.

The strong interest in EEG in the early days may have originated in Dr Schwab's triad: no brainstem reflexes, apnoea and isoelectric EEG (Wijdicks, 2003). The US Collaborative Study was designed by Dr Silverman who was the chairman of the American EEG Society Ad Hoc Committee. His earlier influential paper involved a questionnaire producing data on 2650 isoelectric EEGs. The survey found that 'most recognized that any EEG activity offers

an opportunity for survival' (Silverman *et al.*, 1970). In 23 cases, recovery was found but six EEGs were low voltage. This led to further recommendations on how to record an EEG.

One of the aims of the US Collaborative Study was 'to determine the minimal significant set of clinical, electroencephalographic, laboratory and demographic observations that will be needed for each patient in the definitive study'. EEG was found to be useful and when all drug-induced cases of coma were eliminated, no patient recovered after a 30 min isoelectric EEG (NINCDS, 1980).

Jennett and Pallis' critique of the NINDS Collaborative study was bluntly harsh to say the least, but the pilot study was far from definitive, and some problems have been recognized over the years. The study enrolled comatose, presumably apnoeic patients seen as early 15 min after the ictus and most within 2 h. The US Collaborative Study showed a rostrocaudal deterioration of neurological examinations with many pupils and corneal reflexes tested but far less oculovestibular, swallow or gag reflexes and no apnoea tests were conducted (*The Journal of the American Medical Association*, 1981; Walker, 1985). Apnoea was diagnosed when the patient was not overriding the ventilator and a formal CO₂ challenge was not performed. In fact, during the study, earlier attempts at disconnection of the ventilator resulted in hypoxaemia, leading the investigators to conclude that a formal apnoea test was impractical (NINCDS, 1980; Molinari, 1978). When the EEG was isoelectric, the options were a do-not-resuscitate order or to treat until cardiac standstill, and thus, not all patients may have been given full resuscitative efforts. The patient population was notable for a considerable number of patients with anoxic-ischaemic encephalopathy (20%) and intoxications (15%). More than one-third of the patients had systolic blood pressures <90 mmHg and likely reflected cardiac shock or drug-induced hypotension. The focus of the US Collaborative Study appeared more on finding corroborating EEGs (no less than 2256 EEGs were performed), studying new techniques of cerebral blood flow such as the nuclear scan (Pearson, 1977) and describing neuropathology characteristics, while in principle the UK Code of Practice's position all along has been that a comprehensive clinical examination should suffice. Pallis and Jennett's objection to laboratory tests such as EEG or cerebral flow studies was that if the patient was dead the test was irrelevant, and if the patient was not dead the test was unnecessary.

Further refinement of the criteria was sought, and the Medical Consultants' report, '*Defining Death: A Report on the Medical, Legal and Ethical Issues in the Determination of Death*', to the President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioural Research published more guidelines in 1981 (*Guidelines*, 1981).

The committee consulted Drs Gaetano Molinari, Korein and Earl Walker, investigators of the US Collaborative Study. The report and their opinions may have framed the President's Commission new proposal (NINCDS, 1980). Multiple waiting periods were introduced: 6 h for 'complicated' cases with a confirmatory EEG or a test of cerebral blood flow, 12 h with a well-established irreversible cause of coma without a confirmatory test and 24 h for anoxic brain damage. Finally, an ancillary study was considered important and the observation period could be reduced, if tests showed an

isoelectric EEG or absent cerebral blood flow for 10 min in an adult without drug intoxication, hypothermia or shock. The President's Commission recognized that isoelectric EEG could be caused by drugs ingested in toxic quantities. In a remarkable statement, with similar verbiage in the NINDS Collaborative study report, the President's Commission felt that the UK criteria were 'closer to a prognostic approach' than a 'diagnostic approach'. Apparently, both the US Collaborative Study final report and the President's Commission felt it necessary to compare the UK and US positions. Whether the aforementioned debate sharpened the US views cannot be determined with certainty.

After all, with the passage of time, most of the ambiguity in guidelines was further clarified restoring straightforwardness to the process of brain death declaration. The American Academy of Neurology (1995) practice parameters simplified the requirements after a lengthy and systematic review and relegated the diagnostic laboratory test to a confirmatory status, but also pointed out the uncertainties of these ancillary tests. The American Academy of Neurology practice parameters also provided a guide for precise clinical testing and a method to perform the apnoea test safely.

One view is that in the USA, brain death can be determined only by demonstrating death of the entire brain, while the UK position has been that just the absence of brainstem function would suffice. However in the medical community, since the American Academy of Neurology published its practice parameters in 1995, there has generally been an understanding that both positions are mostly neurologically similar. Pallis remarked that after reading the American Academy of Neurology practice parameters 'Bedside experience seems to have reasserted its primacy and led to a belated convergence of British and American practice over a wide field. Is it too late to hope that within the next few years, the appropriate terminological convergence will follow, and that we will then all be using a common verbal currency, referring to the brainstem death if that is what we mean?' (Pallis and Harley, 1996).

The controversy, however, resurfaced briefly. The President's Council of Bioethics in their 2008 white paper '*Controversies in the Determination of Death*' epitomized a common philosophical interpretation of the brain death concept and 'reaffirmed the ethical acceptability of the neurologic standard', but personal statements by some participants including the chair of the Council, expressed great reservations. The Council also considered the UK position a 'reduction', 'conceptually suspect' and 'clinically dangerous' because 'it suggests that the confirmatory tests that go beyond the bedside checks for apnoea and brainstem reflexes are simply superfluous' (President's Council on Bioethics, 2008).

In 2010, the American Academy of Neurology published an evidence-based update of the literature and concluded that, in adults, recovery of neurological function has not been reported since the clinical diagnosis of brain death was established with the criteria given in the 1995 American Academy of Neurology practice parameter. The document specifically highlighted the preconditions for brain death determination and the potential for pitfalls as Pallis had pointed out so eloquently before (Wijdicks, 2010).

Throughout the world, the criteria for determining brain death vary to some degree (Wijdicks, 2002). In Europe, there has been

considerable variation in the use of EEG or cerebral blood flow studies, with a substantial minority of the countries in the European Union requiring such a test. In the rest of the world, different levels of complexity have been introduced by committees with an interest to introduce safeguards. Major differences between countries remain but these differences mostly involve the time of observation, need for a confirmatory testing and number of physicians required to diagnose brain death. Such a variability of operational guidelines serves little purpose, but a uniform guideline appears elusive.

Supplementary material

Supplementary material is available at *Brain* online

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