The diagnosis of brainstem death and its implications

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The concept of brainstem death is relatively new and has been developed in response to advances in medical treatment such as mechanical ventilation. The idea that it is the same as death of the whole person has been tested in medical research and legally, which has provided evidence to support the withdrawal of advanced medical treatment and for discussion of organ donation.

Until relatively recently the definition of death was a cessation of breathing and the absence of a pulse (Dimond, 2004). However, artificial ventilation can now maintain respiratory function, external chest compressions can maintain circulation and cardiac defibrillation can restore the heart to a functioning rhythm. This means that people who would previously have been considered dead are now seen as being in need of urgent medical attention, which can result in them being kept alive only by artificial ventilation. The areas of the brain required to stimulate breathing have died but the heart continues to beat. This has led to the development of the diagnosis of brainstem death.

**Anatomy of the brain**

In order to understand the importance of the brainstem to the normal functioning of the body it is essential to examine the location and function of this part of the brain. The brain is an organ that is composed primarily of nervous tissue. It can be divided into a number of different areas that perform specific functions in the control of the body.

The largest part of the brain, at approximately 85% of the total weight, is the cerebrum. This folded structure, which is visible when the top of the skull is removed, controls the higher body functions – thought, emotion and language.

The brainstem is much smaller, found at the base of the brain, and is the anatomical link between the spinal cord and the rest of the brain. Its main function is to control the vital functions of the body. Specific areas within it control body temperature, blood pressure and breathing. The brainstem is also responsible for coordinating swallowing, coughing, sneezing, eyeball movement and the maintenance of consciousness (Tortora and Derrickson, 2006).

Damage to the brainstem will affect its functions – severe damage can cause a complete loss of activity in this area. The most immediately important consequence of this will be the inability to breathe. The other immediate impact will be loss of consciousness and coma. Loss of the other brainstem functions will only cause problems over time.

The heart will continue to beat, maintaining circulation and a certain level of blood pressure because the nature of cardiac tissue means the heart can continue to beat without external stimulation. The main role for the brainstem is to alter heart rate and blood pressure in response to changed demand. As the person is unconscious and immobile, demand will not normally change. If it does, for example through blood loss, the heart may no longer be able to maintain an adequate circulation (White, 2003).

The other major change that will occur as a result of damage to the brainstem is a blocking of nervous impulses passing through this region of the brain. This means information travelling up the spinal cord cannot pass through the brainstem to reach the other areas of the brain, such as the cerebrum. Also, the brain is unable to send messages back down the spinal cord to the body.

Damage to the brainstem can occur because of a transient condition within the skull. For example, oedema and swelling of the brain will cause the brainstem to be squashed into the base of the skull. This will cause a temporary loss of function in this section of the brain, which could potentially be reversed by a reduction of the swelling (Eelco and Wijdicks, 2001).
Brainstem death

Brainstem death has been defined as ‘permanent functional death of the brainstem’ (Eynon, 2005). The important thing about this diagnosis is the irreversible nature of this change to the brain. Patients are only diagnosed as brainstem-dead when there is overwhelming evidence that there will be no reversal of their condition.

In adults the most common causes of brainstem death are traumatic brain injury and subarachnoid haemorrhage (Wijdicks, 1995). It can also be the result of indirect causes such as anoxia in drowning or asphyxiation, or ischaemia following blood loss or cardiac arrest.

It is important to note that patients who are diagnosed as brainstem-dead may not appear to be dead because the drugs they are given to maintain blood pressure keep their skin pink and warm, while the ventilator will cause the chest to rise and fall (Edwards and Forbes, 2003). It is also possible that their limbs may move in response to stimuli (Saposnik et al, 2005). This can be distressing for relatives and it is an important role of the nurse to provide support and explain the condition and prognosis.

Diagnosis of brainstem death

History

In the 1950s a number of medical and technical advances resulted in the survival of patients with severe illness who would previously have died. One of the main advances was the development of mechanical ventilation. This sometimes led to a complete recovery but sometimes the patient remained in a comatose state. This condition was first written about in 1957 by two French physicians, Mollart and Goulon, who had observed 23 patients in a state they described as ‘beyond coma’. These patients had signs and symptoms that might now lead to a diagnosis of brainstem death. They were in an irreversible coma with loss of consciousness, had no brainstem reflexes, could not breathe without the assistance of artificial ventilation and had a flat electroencephalogram (Eynon, 2005). The relevance of these observations was not fully appreciated for another decade.

Around this time other medical advances in surgery and immunosuppression made organ transplantation possible and in 1967 Christiana Barnard performed the first heart transplant (Machado, 2005). To succeed, these procedures required an organ donor to have a functioning cardiovascular system until the organs were harvested, which resulted in accusations that hearts were being removed from living people and led to the first definition of brainstem death in 1968 by a committee of the Harvard Medical School. This relied on a series of tests or criteria to establish that further treatment for the patient would be futile (Pittard, 2005). The definition has been refined in the US and similar guidelines have been introduced in other countries. For example, in the UK, the Conference of Royal Colleges and their Faculties published a statement on the diagnosis of brainstem death in 1976, which has been subject to continued modification and refinement ever since.

Diagnostic tests

The tests used to establish brainstem death vary between countries (Eynon, 2005) and even within countries (Powner et al, 2004). It is not within the scope of this article to provide a detailed description

### TABLE 1. BRAINSTEM FUNCTION TESTS CURRENTLY USED IN THE UK (MODIFIED FROM SUNDIN-HUARD AND FAHY, 2004)

<table>
<thead>
<tr>
<th>Function Tested</th>
<th>Result in Brainstem Death</th>
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<tbody>
<tr>
<td>Pupillary reflexes</td>
<td>Absent response to bright light (pupils at midpoint with respect to dilation 4-6mm)</td>
</tr>
<tr>
<td>Facial sensory and motor responses</td>
<td>Absence of grimacing or eye opening in response to pain, for example pressure on the supraorbital ridge</td>
</tr>
<tr>
<td>Corneal reflexes</td>
<td>Absence of grimace/pain response when edge of cornea is touched</td>
</tr>
<tr>
<td>Oculo-vestibular reflex</td>
<td>Absence of response (deviation of eyes towards the side being stimulated by cold, by introduction of icy water into auditory canal)</td>
</tr>
<tr>
<td>Pharyngeal (gag) reflex</td>
<td>Absent – elicited by stimulating rear of pharynx with tongue depressor</td>
</tr>
<tr>
<td>Tracheal (cough) reflex</td>
<td>Absent – elicited by inserting a suction catheter deep into the trachea</td>
</tr>
<tr>
<td>Apnoea testing</td>
<td>No respiratory movements seen if patient is disconnected from ventilator for 10 minutes and pCO2 has reached 6.65kPa</td>
</tr>
</tbody>
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### REFERENCES


Spontaneous and reflex movements


Guided reflection

Use the following points to write a reflection for your PREP portfolio:

- Detail where you work and how this article is relevant to your practice;
- Outline the last time you encountered a patient with brainstem death;
- Identify a new piece of information about brainstem death that you have learnt from this article;
- Describe how this information may help in your future practice;
- Explain how you might disseminate this information to your colleagues.