Is my patient really brain dead?

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Singapore has a Human Organ Transplant Act (HOTA) that makes organ donation automatic, although one can opt out. The act (HOTA) covers all Singapore Citizens and Permanent Residents 21-year-old and above, and who are not mentally disordered, unless they have opted out. There is no upper age limit.
The National Organ Transplant Unit (NOTU) under the auspices of Ministry of Health (MOH) has issued guidelines for determination of brain dead in line with international practices. Brain death is defined as brainstem death with complete loss of brainstem function, determined clinically.
Two fully registered medical practitioners are required for certification of brain death, at least one of whom must not have been involved in the care of the patient. Where organ procurement and donation are contemplated, both certifying medical practitioners must not be involved in the care of either the potential donor or organ recipients.
The Interpretation Act (2002 revision), Part 1, 2A. Criteria for determining death. Available at: http://statutes.agc.gov.sg/

Abstract
The diagnosis of brain death can be fraught with multiple challenges ranging from the presence of complex motor movements to inappropriate patient screening, e.g. patient's not meeting preconditions.
We describe two cases where complex motor movements persisted following clinical death by standard brain death criteria and caused uncertainty with regards to diagnosis of brain death. We wish to highlight that complex motor movements are common and do not always preclude the diagnosis of brain death.

Key words: Brain death, reflex movement, complex motor movement, intensive care.

Brain death (BD) is the irreversible loss of all functions of the brain and brainstem. (1) The diagnosis of BD can be fraught with multiple challenges including the presence of complex motor movements. (1-3) The incidence of these complex motor movements in patients diagnosed with brain death ranges from 13.4 to 79%. (2,3)
We describe two cases where complex motor movements persisted following clinical death by standard brain death criteria and caused uncertainty with regards to diagnosis of brain death.

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Case report 1
A 55-year-old male was brought to the Emergency Department (ED) in asystole with unclear timing of arrest. After 10-minute cardiopulmonary resuscitation in the ED, there was return of spontaneous circulation and the ECG suggested non-ST elevation myocardial infarction. Patient's trachea was intubated, mechanical ventilation and therapeutic hypothermia were initiated in view of GCS of three. Patient did not receive any neuromuscular blocking agents and was on low doses of propofol and fentanyl in view of hypothermia, which were continued approximately for 36 hours only. All brain stem reflexes were absent and the patient was apnoeic from the time of admission to ICU. These findings did not change after rewarming.

Patient had mild acute on chronic kidney injury with a baseline serum creatinine of 210 micromol/L. The urine output increased and serum creatinine stabilized (~300 micromol/L).

Brain MRI was done forty eight hours after rewarming which demonstrated severe diffuse cerebral and cerebellar edema as well as transtentorial and tonsillar herniation suggestive of severe hypoxic ischemic encephalopathy (HIE). On the same day, patient developed diabetes insipidus.

Seventy-two hours after rewarming and cessation of sedation, all cranial nerve reflexes were absent and no response to central painful stimulus could be elicited. The patient needed bronchoscopy due to a complete left lung collapse and high oxygen requirements. No sedation was required for the procedure and no movement was observed during the procedure.

Two hours after the bronchoscopy, nursing staff observed flicker of movement in the right leg during endotracheal tube suctioning. Clinical examination revealed minimal but consistent, right plantar flexion and knee flexion with a supraorbital stimulus, which also pushed the neck. There was no response to sternal rub or local stimulus to the right limb. All cranial nerve reflexes were still absent. Clinical examination two hours later revealed loss of this limb movement to all noxious stimuli including the endotracheal suctioning.

Following discussions with the family regarding the fluctuating neurology, options were explored - to continue observation for another twenty-four hours to confirm death by brain death criteria or to proceed with terminal extubation in view of catastrophic neurological injury. A consensus decision was finally made to proceed with terminal extubation and allow natural death.

Case report 2

An 80-year-old lady was brought to the ED following a witnessed fall. She was conscious at the scene, but became drowsy on the way to hospital. On admission to the ED GCS was three, and the patient's trachea was intubated and mechanical ventilation and sedation were commenced. The brain CT showed diffuse subarachnoid haemorrhage with effacement of the basal cisterns and subdural hematoma. A CT angiogram excluded an aneurysm or AV malformation.

The patient underwent emergency external ventricular drain (EVD) insertion. In the immediate postoperative period, the patient developed very high ICPs. A repeat CT scan revealed worsening of the bleed. Her pupils were dilated with very high ICP readings.

In view of worsening bleeding and associated poor neurological prognosis, decision was made not to offer further surgical intervention.

In the ICU, sedation was stopped; and no neuromuscular blocking agents were administered. Clinical examination revealed fixed dilated pupils and absence of gag reflex, cough reflex and spontaneous respiration.

Neurological examination on day three was consistent with clinical diagnosis of brain death. (1) Later during the day, the patient was noticed to have abnormal movement of right eyelid with rapid eyelid opening followed by slow closure. Assessment by two intensive care physicians confirmed the same and clarified that this movement was not consistent with any verbal or painful stimulus. The movement disappeared by end of the day.

Repeat neurological examination on day four again revealed absent brainstem reflexes and absent respiratory effort on apnea test confirming death by standard brain death criteria. Following discussion with the family, decision was taken to palliate the patient.

Discussion

These two cases highlight the fact that the complex motor movements may cause doubt and can make diagnosis of brain death difficult. The situation gets complicated by the fact that ancillary testing has serious limitations in the diagnosis of BD. (4)

Previously described complex motor movements in the cranial nerve distribution include transient eyelid opening, (5,6) ocular microtremor, cyclical constriction and dilatation in light-fixed pupils and facial myokymia. (2,3)

Other movements that have been described in literature include finger jerks, transient bilateral finger tremor, triple flexion response, Lazarus sign, extension at arms and shoulders, retained plantar reflexes and repetitive leg movements mimicking periodic leg movement during sleep or even decerebrate-like posturing. (2,3) Complex spinal reflexes were reported in BD patients during transcranial doppler (TCD) examination, elicited by neck flexion. (7) The pathophysiological basis for these complex spinal reflexes remains unclear. (8)

For our first case, we are certain, based on our clinical findings and MRI findings, that the patient had irreversible cessation of brain stem function. The abnormal lower limb flexion response within few hours after the bronchoscopy (during which there was no limb movement) could have been triggered by the neck movement during application of supraorbital painful stimulus.

As stated earlier, one case series identified that four out of 161 (2.5%) brain-dead patients had complex spinal reflexes during TCD examination elicited by neck flexion. (7) Interestingly, TCD showed vertebro-basilar circulatory arrest in all four patients in that case series. We believe that the transient motor movements in our patient could have been spinal reflexes elicited by neck flexion. As described by Jain and DeGeorgia, these movements wax and wane over time. (9)

Similarly, the second patient met all the preconditions with no confounding factors and was brain dead clinically, further evidenced by transient nature and subsequent disappearance of abnormal eyelid movement on repeat clinical examination. Similar periodic eye opening has been described in one case report and one case series of four patients. (5,6)

Santamaria et al reported a case of a patient without evidence of brainstem function, but slow eye opening in response to painful stimulation of the ipsilateral nipple; the authors hypothesized that the eyelid opening may have been a mere function of Muller's muscle rather than a reflection of brainstem function. (5) In the case series of four patients, periodic eyelid opening was associated with a burst-suppression pattern on electroencephalography (EEG). (6) Progressive rostrocaudal deterioration in brainstem function ensued, in each case culminating in brain death.

To summarize, we wish to highlight the complexities with regards to the brain death determination. Complex motor movements are common and do not always preclude the diagnosis of brain death.

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