

Apparently Recovering Breath Function in Brain Death

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Brain death (BD) is that someone's brain stops functioning, even though their heart may be kept beating using a machine. After brain function had ceased, somatic function being sustained by mechanical ventilation for a long time. Further treatment is inappropriate in a dead patient. Hence, in many countries, the law provides that treatment can be legitimately removed from a patient who was diagnosed BD and the donation of organs for transplantation can start.

BD evaluation and diagnosis were under development in China. The criteria and practical guidance for the determination of BD in adults was published yet.^[1] In summary, the criteria of the BD diagnoses consist of four steps: (1) The clinical examination confirm the BD diagnose, including deep coma, absence of brainstem reflexes, and no spontaneous respiration; (2) confirmatory tests should fulfill two of the three which include transcranial Doppler (TCD), electroencephalogram (EEG), and somatosensory evoked potential; (3) the apnea test is positive; and (4) a repeat determination should be done 12 h after the first time.

No spontaneous respiration is an essential prerequisite of BD. We have done a series of patients for BD evaluation in Tiantan Hospital. We found some patients seemed to be recovering and had spontaneous breath. This condition has not been reported previously in China. We will report two cases, one case with mechanical ventilation.

A 50-year-old man (case 1) was found lying on the ground with right limbs weakness and difficulties with language. A neurologic examination revealed somnolence, hemiplegia and aphemia. Three days later, he got in a coma. Computed tomography (CT) showed a large left hemisphere lesion.

Two days after clinical deterioration, he was intubated. The next day he was in deep coma and applied for BD evaluation. Neurologic examination was consistent with BD. The apnea test was positive. Ancillary testing with EEG demonstrated electrical silence, supporting the diagnosis of BD. However, the next day; he appeared spontaneous respirations during the patient trigger mode of mechanical ventilation [Video 1]. The apnea test was done again, and the result is positive again. Three days after BD was diagnosed, his families discontinued medicine care. His heart stopped beats the next day.

A 44-year-old man (case 2) suffered a severe headache suddenly. CT showed subarachnoid hemorrhage and right basilar cerebral hemorrhage. His condition was worsening the following day. Another CT showed the blood was more than before. We deduced that was the first rebleeding. He was admitted to the local hospital and placed a drainage tube. Eight days later he was transferred to our hospital and admitted to Intensive Care Unit (ICU). Digital subtraction angiography was arranged 3 days later and showed right posterior communicating aneurysm. The next day he had rebleeding again and slipped into a coma. Three days later he was applied for BD evaluation. Neurologic examination was consistent with BD. The apnea test was positive. EEG demonstrated electrical silence. TCD showed the small systolic spike in both middle cerebral arteries and basilar

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artery. Ancillary testing supported the diagnosis of BD. However, at the next day, he also appeared spontaneous respirations during the patient trigger mode of mechanical ventilation. The BD evaluation including apnea test, EEG, TCD was done again, and the result was positive again. Their families could not accept that he was dead and asked for continuous active treatments. His heart stopped beats 9 days later.

BD examinations were performed by neurologists in Tiantan Hospital Neuro-ICU. The two patients were definite coma with a clear cause. They had electrolyte balance and acid–base balance. Their body temperatures were above 36.5°C, and the systolic blood pressure was maintained >100 mmHg. There was complete brainstem areflexia, including absent pupillary, corneal, oculocephalic, oculovestibular, gag, and cough reflexes. There was no movement in the upper extremities to noxious stimuli.

There are formal definitions of the apnea test in our Neuro-ICU from the US criteria published in 2010.^[2] The patient is preoxygenated during the apnea test. Ventilator should be adjusted to provide normocarbica (PaCO₂ 34–45 mmHg) and hyperoxia (PaO₂ ≥200 mmHg). If respiratory movements are absent in ten minutes and PaCO₂ is ≥60 mmHg or 20 mmHg over a baseline, apnea can be confirmed. Two patients completed the apnea tests 4 times, and all were positive. The PaCO₂ after ten minutes stopping ventilators were 64.4, 77.6, 67.6, and 70.1 mmHg, separately. There were no respiratory movements observed in the test. Hence, their apnea tests were decided to be positive [Table 1].

Ancillary testing also supported the diagnosis of BD. As a conclusion, the two patients were definitely BD. The patient-trigger mode of mechanical ventilation does not mean spontaneous breath.

The concept of BD is closely linked to the birth of modern intensive care medicine. After brain function had ceased, the somatic function being sustained by mechanical ventilation for a long time. Improvements in technology make ventilator facilitate to be triggered. Minimal changes in circuit flow unrelated to the respiratory effort can trigger a ventilator breath and may mislead caregivers in recognizing BD.

Respiratory-like patterns are usually reported during the apnea test. As early as 2000, Willatts and Drummond^[3] reported a patient with cerebral infarction who was certified clinical BD. When she was being ventilated using the biphasic positive airway pressure mode, the “assist” indicator light on the Drager Evita 2 ventilator illuminated intermittently. A separate set of brainstem death certification testing was done, and again the results confirmed brainstem death. The relatives were finally convinced and organs procurement preceded 3 h later than was initially scheduled.

At first, the reason for “triggering” was thought to be caused by a decrease in airway pressure in time with

cardiac contraction.^[3] Later, the definition of “cardiogenic oscillation” was put forward. Arbour^[4] described how cardiogenic oscillation worked in his study in 2009. Ventilator auto-triggering may potentially occur in a brain-dead patient as a result of the interaction between the hyperdynamic cardiovascular system and compliant lung tissue-altering airway pressure and flow patterns. Furthermore, chest wall and precordial movements may mimic intrinsic respiratory drive. He presented ventilator flow and pressure waveforms to explained how the ventilator was triggered by cardiac oscillation [Figure 1].

Cardiogenic ventilator auto-triggering could have delayed or canceled the determination of BD. This phenomenon has been recognized and paid increasingly attention. In 2011, McGee and Mailloux^[5] reported that nine patients were found to be delayed in BD diagnosis in a mixed medical/surgical ICU. He suggested that patients with catastrophic brain injury and absent cranial nerve function should undergo immediate formal apnea testing.

Table 1: Two patients apnea test results

Items	HR (beat/min)	SBP (mmHg)	PO ₂ (mmHg)	PCO ₂ (mmHg)	pH
Patient 1					
1-before	87	121	485	34.3	7.431
1-after	84	122	431	64.4	7.225
2-before	60	175	333	44.3	7.368
2-after	59	114	277	77.6	7.177
Patient 2					
1-before	84	127	221	44.6	7.416
1-after	78	122	105	67.6	7.285
2-before	140	100	393	36.9	7.343
2-after	144	114	356	70.1	7.105

Before means before stopping ventilator. After means After 10 min stopping ventilator. The artery blood gas analysis showed increased PCO₂ and decreased pH after apnea test. Their SBP and HR changed few. SBP: Systolic blood pressure; HR: Heart rate.

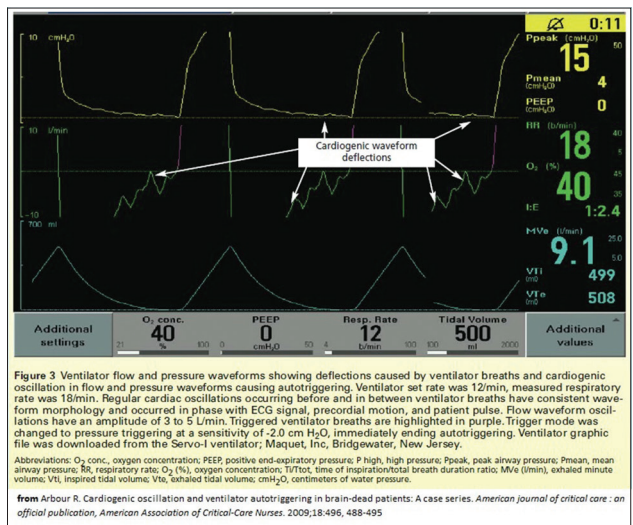


Figure 1: Waveforms of ventilator flow and pressure showed how cardiogenic oscillation worked at triggering ventilator.

In conclusion, we reported two patients with a diagnosis of BD had apparently recovering breath function on the next day. However, the patient-trigger mode of mechanical ventilation does not mean spontaneous breath. Cardiogenic oscillation may be the triggering cause. We should recognize this phenomenon and believe our determination of BD. After all, formal apnea testing is the golden standard for the absence of spontaneous respiration.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Brain Injury Evaluation Quality Control Centre of National Health and Family Planning Commission. Criteria and practical guidance for determination of brain death in adults (BQCC version). *Chin Med J* 2013;126:4786-90.
2. Wijdicks EF, Varelas PN, Gronseth GS, Greer DM; American Academy of Neurology. Evidence-based guideline update: Determining brain death in adults: Report of the Quality Standards Subcommittee of the American Academy of Neurology. *Neurology* 2010;74:1911-8.
3. Willatts SM, Drummond G. Brainstem death and ventilator trigger settings. *Anaesthesia* 2000;55:676-7.
4. Arbour R. Cardiogenic oscillation and ventilator autotriggering in brain-dead patients: A case series. *Am J Crit Care* 2009;18:496, 488-95.
5. McGee WT, Mailloux P. Ventilator autocycling and delayed recognition of brain death. *Neurocrit Care* 2011;14:267-71.