CASE REPORT: BRAIN DEATH DECLARATION FOLLOWING EVIDENCE-BASED GUIDELINES

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RESUMO

Morte cerebral é definhada pelo Ato de Determinação Uniforme de Morte de 1980 como um indivíduo com uma parada irreversível das funções respiratória e circulatória ou total paralisia das funções do cérebro incluído o tronco cerebral. Nos Estados Unidos da América os hospitais seguem as diretrizes da Academia Americana de Neurologia (AAN) que definem a morte cerebral. A literatura mostrou que o diagnóstico de morte cerebral apresenta variações e armadilhas entre os profissionais da saúde. Tais variações e armadilhas podem ser o resultado da falta de confiança de tais profissionais ao fazerem o exame o que se deve ao pequeno número de pacientes que são declarados com morte cerebral como também a falta de uma política clara por parte do hospital para tal diagnóstico. O artigo a seguir discutirá todos os quatro requisitos necessários para diagnosticar a morte cerebral em conjunto com um exame neurológico completo de uma paciente com 18 dias de pós-parto que teve um derrame cerebral hemorrágico e foi declarada com morte cerebral.
Palavras-chave: Morte cerebral. Exame neurológico. Academia Americana de Neurologia. EUA.

ABSTRACT

Brain death is defined by the Uniform Determination of Death Act 1980 as an individual who has sustained either an irreversible cessation of circulatory and respiratory function, or irreversible cessation of all functions of the entire brain including the brainstem. In the United States of America, hospitals follow the American Academy of Neurology (AAN) evidence based guidelines to determine brain death. Literature has shown that a diagnosis of brain death has variance and pitfalls among clinicians. These variances and pitfalls may be the result of lack of confidence of clinicians performing the examination, which is due to the small numbers of patients who are declared brain dead, followed by a lack of well-defined hospital policy. This case report will discuss all the four requirements necessary to diagnosis brain death in conjunction with a complete neurological examination of an 18 days postpartum patient who developed a hemorrhagic stroke and was declared brain dead.

Key words: Brain death. Neurological examination. AAN. USA.

INTRODUCTION

According to the Uniform Determination of Death Act (UDDA) 1980, brain death is defined as "an individual who has sustained either 1. Irreversible cessation of circulatory and respiratory function, or 2. Irreversible cessation of all functions of the entire brain including the brainstem is dead. A determination of death must be made with accepted medical standards" (Wijdicks, Varelas, Gronseth, Greer, 2010, p. 1911).

Evaluation for brain death occurs to determine whether additional life support should be given to the patient and whether the patient is a candidate for organ donation. In the United States of America (USA), there is no precise standardization of brain death criteria, therefore, protocols and procedures may vary among hospitals (Wijdicks, et al, 2010, p. 1911). Furthermore, it is significant to state that most of the hospitals base their criteria on the American Academy of Neurology (AAN) evidence based guidelines (2010) for the determination of brain death. The AAN evidence-based guidelines were first published in 1995. In 2010, the guidelines were updated by the AAN's Quality Standards Subcommittee (Wijdicks et al, 2010, p. 1911).

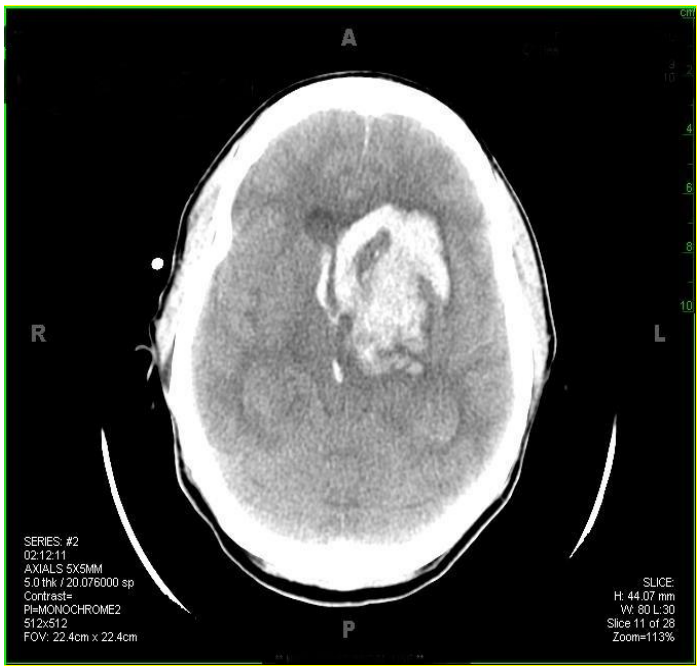
In the USA, 1% to 2 % of all annual deaths are brain deaths (Jackson, Willmarth-Stec & Shutter, 2014 p. 44). Literature has shown that a diagnosis of brain death has variance and pitfalls among clinicians. These variances and pitfalls may be the result of lack of confidence of clinicians performing the examination, which is due to the small numbers of patients who are declared brain dead, followed by a lack of well-defined hospital policy (Jackson, Willmarth-Stec & Shutter, 2014 p. 45).

Clinicians must be familiar with the determination of brain death and the current guidelines so patients are not determined brain dead by mistake. The criteria emphasize three clinical findings necessary to confirm irreversible cessation of all functions to the brain. It includes a coma, which is not reversible with a known cause, absence of brainstem reflexes and apnea (Busl & Greer, 2009, p. 276).

CASE REPORT

A 39-year-old African- American female who had a C-section for a full-term breech presentation, developed preeclampsia 10 days post-partum. At that time, she presented to the emergency department (ED) with a systolic blood pressure (SBP) of 180. The patient was monitored for 2 days and discharged home on labetalol 100 mg bid. At discharge, her blood pressure (BP) was 112/84. However, 6 days later, she returned to the emergency room with her husband with mental status changes and vomiting. Her past medical history included hypothyroidism. No tobacco use, ETOH, or illicit drug use. During pregnancy she followed up her prenatal care appointments and had normal blood pressure.

Upon arrival to the ED her BP was 174/84. No apparent trauma was documented, nor was the patient on anticoagulants. She was lethargic with right hemiparesis. She was intubated for airway protection. A computerized tomography (CT) scan of the head was performed which showed a large intraparenchymal hemorrhage centered about the left basal ganglia and dilatation of the ventricular system, with approximately 6 to 7 mm rightward midline shift (see CT of the head below).



Neurosurgery was consulted and an external ventricular drain (EVD) was performed in the ED. CT angiogram of the head and neck, showed no evidence of aneurysm or arteriovenous malformation (AVM). The distribution of hemorrhage was suggestive of hypertensive etiology. The patient was transferred to the Neuro Intensive Care Unit (Neuro ICU) and a Nicardipine drip was used to keep systolic blood pressure (SBP) less than 140mmHg and a Diprivan drip at 2.0 mg/kg to keep the patient sedated.

Laboratory data showed ABG pH 7.37, $PaCO_2$ 35.5 mmHg, pO2 499 mmHg and bicarbonate of 20.4mEq/L on FLO2 of 100% post intubation. WBC $5.4x10^3/\mu L$, hemoglobin 12.6 g/dL, platelets 251 billion/L. Urinalysis was negative, no proteinuria, urine drug screen also negative, BUN 7 mg/dL, creatinine 0.5mg/dL, sodium 140 mEq/L, potassium 3.7 mEq/L , chloride 102 MEq/dL, bicarbonate 23 mEq/L, calcium 8.7 mg/dL and magnesium 1.8 mg/dL. Liver function test and thyroid function within normal limits.

Two days after presentation the patient was not assisting or triggering the ventilator to breathe and a decision was made to discontinue sedation. Twenty-four

hours after sedation was discontinued the patient was examined and findings included an absent gag reflex, absent oculocephalic reflex, absent pupillary light reflex bilaterally, absent corneal reflex bilaterally and absent response to noxious stimulus. Findings were discussed with the intensivist and a decision was made to proceed with brain death determination by following the hospital policy.

Four days after admission, the first brain death examination was performed. Six hours later after the first brain examination, a second examination was done by a different clinician with an apnea test. The patient was declared an irreversible cessation of all brain functions and therefore, declared dead. A cerebral flow study was also performed per family request and showed lack of cerebral flow in the brain.

This case prompted the author to discuss a thorough brain death examination due to the uniqueness of this patient history and the inconsistency of clinicians in performing brain death examination, specifically related to the apnea test.

Furthermore, the patient followed up all her appointments with her obstetrician and had no history of hypertension or preeclampsia during her pregnancy. The incidence of hemorrhagic stroke during pregnancy and postpartum period is up to 6 per 100,000 in reported cases (Razmara, Bakhadirov, Batra & Feske , 2014 p.532).

According to Al-Safi et al. (2011 p. 1103) there is an increase frequency of cases of eclampsia occurring in the postpartum period. This could be due to the persistence and progression of preeclampsia that started during the intrapartum period or after delivery but unrecognized before discharge. Based on this patient medical history, it is possible she had preeclampsia, which was unrecognized before discharge.

DISCUSSION

According to the AAN, there are four prerequisites necessary to determine a brain death diagnosis. First, the cause of coma must be determined by history, clinical exam, neuroimaging, and laboratory testing. The standard of care for neuroimaging is a CT scan or magnetic resonance (MRI) (Wijdicks et al, 2010, p. 1914).

The second criteria to determine a brain death diagnosis is normal core temperature (>36 degrees Celsius). In many patients a warming blanket is used to achieve a normal temperature. The third prerequisite is a normal systolic blood pressure, higher or equal 100mm Hg. In order to achieve a normal blood pressure, vasopressors or vasopressins are often started in hypotensive patients. Lastly, there must be at least one neurological exam to pronounce brain death. Many states statues in the USA require two examinations (Wijdicks et al, 2010, p. 1914-1915).

It is critical for the clinician to exclude the presence of central nerve system (CNS) depressant drugs such as opioids, barbiturates, benzodiazepines, tricyclic antidepressants, by checking a drug screen and by reviewing the patient's history of drug or alcohol abuse. Ingested in large quantities, drugs can cause a partial loss of brain stem reflexes (Hills, 2010 p. 37). If the drug or poison is present but the substance cannot be quantified, the patient should be observed for a period that is at least 4 times the elimination of half-life of the drug (Spinello, 2015). Moreover, hypotension, hypoxemia, hypothermia and electrolytes imbalance must be ruled out before starting a brain death declaration (Hills, 2010, p.37). Clinicians should be aware that hypothermia could also mimic brain death. A patient with a core temperature less than 32 degrees Celsius may lose all brainstem reflexes, and not be able to shiver (Hills, 2010, p.37).

Once these four prerequisites have been met and the patient's neurological examination in unchangeable a brain death evaluation can be performed. Our

institution policy requires two brain death examinations at least six hour apart performed by an attending physician, at least one of whom is a neurologist, neurosurgeon or intensivist to determine brain death. It also states that the examiner cannot be affiliated with the transplant or organ donation team (Brain Death Determination, 2013, p. 4).

First, noxious stimuli is applied to the cranial nerve territory. While applying noxious stimuli, the patient should have absent response to pain. Noxious stimuli can produce a spinal reflex such as triple flexion reflex, plantar movement, leg movement, finger movement or facial movements (Wijdicks et al, 2010, p.1915). The clinician must explain the spinal reflexes to family members and offer them supportive care, as they may be very upset when observing spinal reflex movements and think their loved one is responding.

Next is the pupillary light reflex test. Using a pen light, the pupillary light reflex must be absent in both eyes and the pupils must be fixed (4 to 9mm). When checking the pupillary response, we are assessing cranial nerve (CN) II and III (Wijdicks, et al 2010, p.1915).

When testing corneal reflexes CN V, the clinician uses a 2x2 inches gauze or cotton swab and gently touch the cornea and no eyelid movement should occur. Next, the clinician should test CN III, IV, VI, oculocephalic and oculovestibular exams. Before performing oculocephalic testing or doll's eyes testing it is fundamental to rule out cervical spinal injury. Holding both eyes open, the practitioner turns the patient's head horizontally and vertically in a quick motion, the eyes should be midline with no movement (Hills, 2010, p.37).

The next assessment is the cold caloric or oculovestibular reflex test. It is tested by elevating the head 30 degrees and injecting 30 to 50 ml of ice water in each ear slowly over 30 seconds with a 5-minute wait between injections in each ear. While injecting the ice water, the practitioner should keep both eyes open to verify movements of the eyes. Movement of the eyes should be absent during one minute of observation. If a patient shows eye movement from side to side while injecting

water followed by a rapid eye movement, brain death examination should be stopped as the patient is having brainstem function (Hills, 2010 p.37). According to my institution policy, eye movement should be absent for two minutes.

The oropharyngeal or gag reflex test, CN IX and X follows the cold caloric examination. This test can be performed with a tongue depressor or a suction catheter by stimulating the back of the throat. A gag response indicates the gag reflex is present (Wijdicks et al, 2010, p.1915). A cough response to tracheal suction is not part of our policy, however, while determining brain death, we check for cough response.

The next part of the neurological examination is the absence of spontaneous respirations (the patient is not assisting or triggering the ventilator) and apnea test. According to our policy, the apnea test is only performed once by the second examiner (Brain Death Determination, 2013 p. 3). In order to initiate this test, a baseline $PaCO_2$ level must be measured by performing an arterial blood gas. Normal range for $PaCO_2$ is 35 to 45 mmHg. If the arterial blood gas (ABG) is not within this range, the settings on the ventilator should be changed until carbon dioxide is normal. Next we preoxygenate the patient for at least 10 minutes with 100% oxygen to a PaO_2 > 200mmHG. Preoxygenating the patient with 100% oxygen eliminates storage of nitrogen and facilitates oxygen transportation (Wijdicks et al, 2010, p. 1916).

Once a patient has normal carbon dioxide level and is preoxygenated, we disconnect the patient from the ventilator and insert a cannula through the endotracheal tube close to the carina and deliver oxygen flow at 6 L/min. We monitor the patient for 8 to 10 minutes watching for chest and abdomen movement or gasp. If respirations are not elicited, another ABG test should be performed and the patient is placed back on the ventilator. A rise in the $PaCO_2$ greater than 20 mmHg above the baseline or greater than 60mmHg demonstrates that the apnea test is positive and brain death is declared. The apnea test should be canceled if SBP

decreases <90 mmHG or if pulse oximeter (PO) is < 85% for > 30 seconds (Wijdicks, et al 2010, p. 1916).

The hospital policy is not clear on how to perform the apnea test, and it has been observed that some clinicians in this institution are not comfortable performing the apnea test. The apnea test is the most important part of the examination. If not performed correct, the patient can decompensate and have complete cessation of circulation (Jackson, Willmarth-Stec & Shutter, 2015 p. 45). The policy needs to be updated to better equip clinicians when performing an apnea test. Educational modules such as a video demonstration of brain death examination can be also utilized to demonstrate to clinicians a through brain death examination.

According to the AAN a validating test is not required to confirm brain death, however, patients in whom a neurological examination is not reliable, ancillary tests may be required.

The gold standard for confirming the absence of blood flow is conventional 4-vessel angiography. This test is expensive, invasive and time-consuming (Practice Parameter for determining brain death in adults, 1995, p. 1012; Spinello, 2015). Nuclear medicine brain imaging static with vascular is used to diagnosis absence of cerebral blood flow. An electroencephalogram, which shows a graphic record of electrical activity of the brain, can also be used as an ancillary test. These confirmatory tests are not mandatory in the USA and can be used when the apnea test cannot be performed or the neurological examination is not reliable (Spinello, 2015).

Regarding this patient, a nuclear medicine brain maging test was ordered as her husband was having a difficulty in accepting his wife's brain death declaration. In the USA, brain death is documented in the patient's record and the time of death is the time the PCO_2 rises. In case of apnea test is discontinued, the time of brain death is when the ancillary test has been interpreted by a radiologist (Wijdicks, et al 2010, p. 1916).

According to the federal law in the USA, a health care provider should contact an organ procurement organization before declaring brain death (Wijdicks, et al 2010, p. 1916).

The organ procurement organization in the state of Michigan is The Gift of Life. It is the only federally designated organ and tissue recovery program, providing all services necessary for organ donation to occur in Michigan. They are a non-profit organization working 24 hours a day all over the state as a liaison between donors, hospitals and transplant centers (Brain Death Determination, 2013, p. 4).The Registered Nurse (RN) contacted The Gift of Life before we started our first brain death examination. The organization sent us a coordinator who approached the husband regarding organ donation and he declined it.

CONCLUSION

The key to declaring brain death is a thorough neurologic exam with apnea test after all the complicating conditions are ruled out. It is important for clinicians to be aware that a neurologic examination cannot be replaced with ancillary tests. The diagnosis of brain death should follow the institution policies, which should be based on the AAN. The four prerequisites must be met before initiating a brain death examination. Hospitals should have policies based on the AAN evidence-based guidelines and have neurologists and well trained clinicians to perform brain death examination. Educational modules can be also used to demonstrate to clinicians a complete brain death examination.

Brain death declaration remains a challenge for clinicians. Patients are unlikely to be determined brain dead mistakenly if detailed policies are followed by hospitals.

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