Title: A Request to Administer Anesthesia for a Child Who is Diagnosed with Brain Death

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Objectives:

1. Discuss the appropriateness of anesthesia or surgical procedure on a patient diagnosed with brain death.
2. Define the criteria for brain death in a child or adult.
3. Review the legal rights and responsibilities of the patient, parents, physician, and hospital in the case of brain death.
4. Describe the spinal reflexes and physiologic changes that may occur in a patient diagnosed with brain death.
5. Develop an anesthetic plan for management for organ retrieval and discuss potential complications.

Case History:

You are called by the general surgeon to anesthetize a 10 year-old child in the PICU for a tracheostomy and gastrostomy tube placement. When you go see the child, you learn that he had a catastrophic cardiac arrest while undergoing a routine laparoscopic appendectomy 10 days ago. He was resuscitated, and has been in the ICU since with severe neurologic injury. The ICU team is in the process of determining whether the child is brain dead. The parents want everything done for their child and have asked the surgeons to perform the procedures so the child can be transferred to a chronic care facility.

Questions: What do you think of the surgeon's request? Who would you discuss this case with? If you are assigned to complete the preoperative assessment on this patient, how would you proceed?

Case progression: Upon further review of the chart, you find out that a hypothermic protocol was initiated immediately after resuscitation and he was maintained at 34 degrees for 48 hours before rewarming.

Questions: How does the institution of the hypothermic protocol one week ago affect your

management plan? Does it matter if the hypothermia was terminated 7 days ago vs just 24 hours ago? Why?

Case progress: You examine the patient and find that he is not responsive to stimulation. Upon reviewing the chart, you find out that currently, he is on a dexmedetomidine infusion at the family's insistence to "keep him comfortable" while he is intubated. The ICU team believes the patient is likely brain dead.

Questions: What is brain death? What diagnostic tests must be performed to determine brain death? Who (what specialists) should perform these tests? Who should interpret the results? What is significant about the dexmedetomidine infusion?

Exam results and case progression: The dexmedetomidine infusion is stopped. Twelve hours later, the initial exam is done by the board certified pediatric intensive care attending who is responsible for the patient's care. At the time of the exam, the patient's temperature is 36.5 C and the blood pressure is 98/46. The result of the exam is: 5 mm symmetric pupils without response to light, no "dolls eye" or vestibulocochlear reflex, no corneal reflex to touch, no gag, no cough with tracheal suctioning. No respiratory effort during the apnea test with an arterial $PaCO_2$ of 69 mm Hg after 8 minutes.

Questions: Can the attending of record be the physician who performs the exam? Why or why not? What is the significance of the results of the initial brain death exam? What other tests are supportive of the diagnosis?

Case progression: 24 hours later, a second exam is completed by a board-certified pediatric neurologist who is familiar with the patient, but is not currently part of the patient's care team. The results of his exam are 5.5 mm symmetric pupils without response to light, no "dolls eye" or vestibulocochlear reflex, no corneal reflex to touch, no grimacing to deep pressure of the TMJ, no gag with tongue blade, no cough with bronchial suctioning. No respiratory effort during the apnea test with an arterial $PaCO_2$ of 72 mm Hg after 9 minutes.
The parents insist they want to proceed with the gastrostomy tube and tracheostomy tube.

Questions: Is it appropriate to perform anesthesia on a child who *is* brain dead? What are the legal rights of the parents, patient, medical staff, and hospital in this situation?

Case progression: Despite the test results, they are certain their child is alive and will recover. To support this, they state that the child has been observed to intermittently turn his head from side to side, bend his arms, bend at the waist, and move his legs. On your physical exam, the patient has triple flexion of the lower extremities. Noxious stimulation of the left upper extremity results in flexion at the elbow and supination of the arm such that the arm ends up resting on the patient's abdomen.

Questions: How would these physical exam findings change your management? What do you do now?

Case Progression: Five days later, after further family meetings with the medical team, additional neurological exams by a pediatric neurologist and neurosurgeon from another hospital, discussions with the hospital legal team, chaplain, social workers, explanations of the

patient's status, the parents have slowly come around and accept the diagnosis. They now wish to donate the child's organs. You are now asked to manage the anesthesia for the organ retrieval procedure.

Questions: What are the anesthetic considerations for organ retrieval? Are there alternative plans for administering anesthesia in this patient?

Case progression: The patient is transported to the operating room, prepped and draped. The VS are HR 92, arterial BP 93/50. The surgeon makes incision and the HR increases to 124 and the arterial BP increases to 126/72. The circulating nurse asks that we stop the surgery because the patient responded to incision and thus is not brain dead.

Questions: What do you do? How would you address this issue? What is the meaning of the hemodynamic response to incision?

Discussion:

As recent high profile media cases demonstrate, brain death can be a complicated subject for physicians, families, and the general public. Although brain death is clearly defined by the neurologic community and these guidelines are widely accepted by other specialty societies, the current practice of medicine is increasingly open to patient and family contributions in medical decision making.

Confirmation of brain death must meet a number of criteria. There must be absence of neurological function with a known irreversible cause of coma. Certain conditions (including hypotension, hypothermia, metabolic derangements) may confound the evaluation and thus must be corrected prior to neurologic evaluation. Medications which may affect the neurologic exam (including sedatives, neuromuscular blockers, and anticonvulsants) must be discontinued prior to the exam. Neurologic recovery after cardiopulmonary resuscitation or severe acute brain injury must be allowed, so the brain death exam should occur >24-48 hours after such an event. The clinical evaluation must be significant for the absence of: pupillary response to bright light; movement of bulbar musculature; gag, cough, sucking and rooting reflexes; corneal reflexes and eyelid movement; and oculovestibular reflexes during ice water irrigation of the ear. Apnea testing must be done according to specific criteria and if cannot be completed, ancillary studies including EEG, radionuclide cerebral blood flow studies, or assessment of spinal cord reflexes for abnormal movements should be completed.

One possible reason brain death is difficult for family members to accept is that spinal reflexes and automatisms which appear to be complex movements may continue to be present. These may include the "Lazarus sign," extension-pronation movements of the upper extremities, eye opening response, isolated upper extremity jerks, leg movements mimicking periodic leg movement, and facial myokymia, among others. Sudden changes in blood pressure and heart rate may be noted on initial surgical incision in a brain dead patient, causing further confusion. The exact etiology of these movements and responses is unclear although a number of hypotheses have been proposed.

In addition to being involved in brain death diagnosis, anesthesiologists are often asked to provide anesthetic management for organ procurement once the diagnosis has been made.

Because the spinal cord is intact and somatic and visceral reflexes remain, muscle relaxants should be administered and vasodilators may be required to suppress the hypertension and tachycardia associated with surgical incision.

Caring for a patient who is diagnosed with brain death is medically, ethically, legally, and socially challenging. For these reasons, the care of these complex patients should include a multidisciplinary team involving multiple medical specialists, social services, and medical ethicists. When appropriate, hospital legal personnel may be consulted. Most importantly, all of these issues must be addressed in the context of prioritizing the patient and family's best interests while balancing the principles of autonomy, beneficence, nonmaleficence, and justice.

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