Brain Death Examination Importance and Pitfalls

Dr. Reshi
Professor of Neurology/Neurosurgery
University of Minnesota
Conflict

- No Conflicts to report
- Will not discuss off label use of any medication.
Presentation Objectives

- To present the key findings of the update of the 1995 American Academy of Neurology (AAN) guideline\(^1\)
- To present evidence-based recommendations for Brain Death Examination
- Identify areas for improvement
So why should we worry about Brain Death?

- 1) Reduce cost of healthcare.
- 2) Recovery of coma is very unrealistic.
- 3) We need organs for donation.
- 4) All of the Above.
- 5) None of the above.
98% of respondents had heard of brain death, but only one-third (33.7%) believed that a person who had been declared brain dead was legally dead. Furthermore, 28.1% thought brain-dead people can hear, and only 40.4% classified someone who is brain dead as dead. Rather, 43.3% characterized persons who are brain dead as “good as dead,” and 16.0% stated that they are alive.

doctors would deliberately remove a patient’s organs, before the patient had died, whereas others believed that life-saving medical care would be withheld so that patients could become eligible for organ donation. (Newton, et al.)

It Matters: We got to get this right.

- Because one mistake undermines the trust.
- Confirms the perceived conflict of interest.
- Robs many organ recipient’s of possible life.
- Robs the family and friends of a proper grieving.
Brain Death: History

- 1968 Harvard Ad hoc committee published paper on “irreversible coma”
- These Criteria got adopted into “Brain Death Criteria” around 1970’s by different states.
- In 1981 a Presidential commission issued “Defining Death: Medical, Legal, and ethical issues”
  - Report used to adopt “Uniform Determination of Death Act” by 39 States.
- AAN came up with recommendations in 1995 to examine patients for Brain Death.
- Revised in 2010.
Definition

• The President’s Commission report on “guidelines for the determination of death”\textsuperscript{2} culminated in a proposal for a legal definition that led to the Uniform Determination of Death Act (UDDA). The act reads:
  ▪ “An individual who has sustained either 1) irreversible cessation of circulatory and respiratory functions, or 2) irreversible cessation of all functions of the entire brain, including the brain stem, is dead.
  ▪ A determination of death must be made with accepted medical standards.”\textsuperscript{3}
Why should I trust the process

1. Are there patients who fulfill the clinical criteria of brain death who recover brain function?
2. Are complex motor movements that falsely suggest retained brain function sometimes observed in brain death?
AAN Study

- MEDLINE and EMBASE
  - January 1996 to May 2009
  - A secondary bibliography search of all full-text articles
  - Relevant, fully published, peer-reviewed articles
  - Search terms included the MeSH term brain death and the text words brain death, irreversible coma, and apnea test.
Literature Review

367 abstracts

38 articles

Exclusion criteria:
- Articles that studied patients younger than 18 years
- Articles that confirmed prior observations
- Review articles, bioethical reviews, articles without description of a brain death examination
- Articles with questionable practices or describing rarely used ancillary technology
Question 1: Are there patients who fulfill the clinical criteria of brain death who recover brain function?
Conclusion:

• In adults, recovery of neurologic function has not been reported after the clinical diagnosis of brain death has been established using the criteria given in the 1995 AAN practice parameter.

Recommendation:

• The criteria for the determination of brain death given in the 1995 AAN practice parameter have not been invalidated by published reports of neurological recovery in patients who fulfill these criteria (Level U).
Analysis of Evidence

**Question 2:** Are complex motor movements that falsely suggest retained brain function sometimes observed in brain death?
Conclusion/Recommendation

**Conclusion:**

- For some patients diagnosed as brain dead, complex, non-brain-mediated spontaneous movements can falsely suggest retained brain function. Additionally, ventilator autocycling may falsely suggest patient-initiated breathing.

**Recommendation:**

- Complex–spontaneous motor movements and false-positive triggering of the ventilator may occur in patients who are brain dead (Level C).
Clinical Context

- Much of the framework necessary for the development of “accepted medical standards” for the declaration of brain death is based on straightforward principles.
- These principles can be derived from the definition of brain death provided by the UDDA.
Process Overview

1. Patient in coma
2. Evidence of Injury: Irreversible, Catastrophic whole brain injury on imaging
3. No obvious metabolic cause, medication or intoxicant to explain this.
4. Neurological Exam – No Brain stem or cerebral function
5. Apnea testing
6. Ancillary testing (if Needed)
Practical Guidance for Determining Brain Death.

First Condition

- Coma.
  - Patients must lack all evidence of responsiveness.
    - Eye opening or eye movement to noxious stimuli is absent. Noxious stimuli should not produce a motor response other than spinally mediated reflexes.

- Evidence of Catastrophic Irreversible Whole Brain Injury

- Absence of ALL brainstem reflexes.
1. The clinical evaluation (PREREQUISITES).

- Establish IRREVERSIBLE and proximate cause of coma.
  - The cause of coma can usually be established by history, examination, neuroimaging, and laboratory tests.
- Rule out CNS-depressant Drug effect.
  - **Drug screen. 5 times** the drug’s half-life, or **drug plasma levels** below the therapeutic range. Prior use of hypothermia may delay drug metabolism.
- Neuromuscular blocking agents (this can be defined by the presence of a train of four twitches with maximal ulnar nerve stimulation).
- There should be no severe electrolyte, acid-base, or endocrine disturbance (defined by severe acidosis or laboratory values markedly deviated from the norm).
- Rule out other metabolic reasons for Coma, e.g. Hepatic coma, Sepsis etc.
What Happens Next

- Treatment team makes plans for further examination
- Nursing staff can inform Organ Donation Agency to evaluate the patient in the background. No contact with family at this point.

- Federal and state law requires the physician to contact an organ procurement organization following determination of brain death.4,5
Achieve normal core temperature.
- In most patients, a warming blanket is needed to raise the body temperature and maintain a normal or near-normal temperature (>36°C). After the initial equilibration of arterial carbon dioxide with mixed central venous carbon dioxide the PaCO$_2$ rises steeply, but then more slowly when the body metabolism raises PaCO$_2$. To avoid delaying an increase in PaCO$_2$, normal or near-normal core temperature is preferred during the apnea test.

Achieve normal systolic blood pressure.
- Hypotension from loss of peripheral vascular tone or hypovolemia (diabetes insipidus) is common; vasopressors or vasopressin are often required. Neurologic examination is usually reliable with a systolic blood pressure $\geq$100 mm Hg.
Perform First neurologic examination

- Comatose patient, irreversible cause established, other causes of coma ruled out ---- PROCEED with Neurological examination.

- Legally, all physicians are allowed to determine brain death in most US states.

- Neurologists, neurosurgeons, and intensive care specialists may have specialized expertise.

- Physicians making a determination of brain death be have demonstrated competence in this complex examination.

- Brain death statutes in the US do differ by state and institution. Some US state or hospital guidelines require the examiner to have certain expertise.
Practical Guidance for Determining Brain Death, cont.

2. The clinical evaluation (neurologic assessment).

- **Coma.**
  - Patients must lack all evidence of responsiveness.
    - Eye opening or eye movement to noxious stimuli is absent. Noxious stimuli should not produce a motor response other than spinally mediated reflexes.

- **Absence of brainstem reflexes.**
  - Absence of pupillary response to a bright light is documented in both eyes.
    - Usually the pupils are fixed in a midsize or dilated position (4–9 mm). Constricted pupils suggest the possibility of drug intoxication. When uncertainty exists a magnifying glass should be used.
Practical Guidance for Determining Brain Death, cont.

- Absence of ocular movements using oculocephalic testing
  o Once the integrity of the cervical spine is ensured, the head is briskly rotated horizontally and vertically. There should be no movement of the eyes relative to head movement.

- Absence oculovestibular reflex --- Cold Caloric Testing.
  o The oculovestibular reflex is tested by irrigating each ear with ice water (caloric testing) after the patency of the external auditory canal is confirmed.
  o The head is elevated to 30 degrees.
  o Each external auditory canal is irrigated (one ear at a time) with approximately 50 cc of ice water. Movement of the eyes should be absent during 1 minute of observation. Both sides are tested, with an interval of at least five minutes.

- Absence of corneal reflex.
  o Absent corneal reflex is demonstrated by touching the cornea with a piece of tissue paper, a cotton swab, or squirts of water. No eyelid movement should be seen.
Practical Guidance for Determining Brain Death, cont.

- **Absence of facial muscle movement to a noxious stimulus.**
  - Deep pressure on the condyles at the level of the temporomandibular joints and deep pressure at the supraorbital ridge should produce no grimacing or facial muscle movement.

- **Absence of the pharyngeal and tracheal reflexes.**
  - The pharyngeal or gag reflex is tested after stimulation of the posterior pharynx with a tongue blade or suction device. The tracheal reflex is most reliably tested by examining the cough response to tracheal suctioning. The catheter should be inserted into the trachea and advanced to the level of the carina followed by one or two suctioning passes.
Practical Guidance for Determining Brain Death, cont.

- Apnea.
  - Absence of a breathing drive.
    - Absence of a breathing drive is tested with a CO₂ challenge. Documentation of an increase in (partial pressure of carbon dioxide [PaCO₂] above normal levels is typical practice. It requires preparation before the test.

- Prerequisites.
  - Normotension
  - Normothermia
  - Euvolemia
  - Eucapnia (PaCO₂ 35–45 mm Hg)
  - Absence of hypoxia
  - No prior evidence of CO₂ retention (i.e., chronic obstructive pulmonary disease, severe obesity)
Practical Guidance for Determining Brain Death, cont.

Procedure.
- Adjust vasopressors to a systolic blood pressure ≥100 mm Hg or have them available.
- Preoxygenate for at least 10 minutes with 100% oxygen to a PaO\textsubscript{2} >200 mm Hg.
- Reduce ventilation frequency to 10 breaths per minute to eucapnia.
- Reduce positive end-expiratory pressure (PEEP) to 5 cm H\textsubscript{2}O (oxygen desaturation with decreasing PEEP may suggest difficulty with apnea testing).
- If pulse oximetry oxygen saturation remains >95%, obtain a baseline blood gas (partial pressure of oxygen [PaO\textsubscript{2}], PaCO\textsubscript{2}, pH, bicarbonate, base excess).
- Disconnect the patient from the ventilator.
- Preserve oxygenation (e.g., place an insufflation catheter through the endotracheal tube and close to the level of the carina and deliver 100% O\textsubscript{2} at 6 L/min).
- Look closely for respiratory movements for 8–10 minutes. Respiration is defined as abdominal or chest excursions and may include a brief gasp.
Abort if systolic blood pressure decreases to <90 mm Hg.

Abort if oxygen saturation measured by pulse oximetry is <85% for >30 seconds. Retry procedure with T-piece, continuous positive airway pressure (CPAP) 10 cm H$_2$O, and 100% O$_2$ 12 L/minute.

If no respiratory drive is observed, repeat blood gas (PaO$_2$, PaCO$_2$, pH, bicarbonate, base excess) after approximately 8 minutes.

If respiratory movements are absent and arterial PCO$_2$ is ≥60 mm Hg (or 20 mm Hg increase in arterial PCO$_2$ over a baseline normal arterial PCO$_2$), the apnea test result is positive (i.e., supports the clinical diagnosis of brain death).

If the test is inconclusive but the patient is hemodynamically stable during the procedure, it may be repeated for a longer period of time (10–15 minutes) after the patient is again adequately preoxygenated.
All Criteria Met

- Patient should be declared DEAD 
  (By Brain Death Criteria)

- Activity found: ---- ABORT testing.

- Meets Criteria ---- Cant complete Apnea Testing
  - Next Step: Confirmatory Testing.
Practical Guidance for Determining Brain Death, cont.

- **Ancillary tests.**
  - EEG, cerebral angiography
  - Nuclear scan
  - Transcranial Doppler (TCD),
  - CT angiography (CTA), and MRI/magnetic resonance angiography (MRA)
  - Ancillary tests can be used when uncertainty exists about the reliability of parts of the neurologic examination or when the apnea test cannot be performed.
Practical Guidance for Determining Brain Death, cont.

- Expertise is required. In adults, ancillary tests are **not needed** for the clinical diagnosis of brain death and **cannot replace** a neurologic examination.

- Physicians ordering ancillary tests should appreciate the disparities between tests and the potential for **false positives** (i.e., the test suggests brain death, but the patient does not meet clinical criteria).

- Rather than ordering ancillary tests, physicians may decide not to proceed with the declaration of brain death if clinical findings are unreliable.
Practical Guidance for Determining Brain Death, cont.

- **Documentation.**
  - The time of brain death is documented in the medical records. Time of death is the time the arterial PCO$_2$ reached the target value. In patients with an aborted apnea test, the time of death is when the ancillary test has been officially interpreted. A checklist is filled out, signed, and dated.

- Federal and state law requires the physician to contact an organ procurement organization following determination of brain death.$^{4,5}$
Where Can it go Wrong: Pitfalls

- Patient Selection
- Potential Bias
- Examination
- Test Selection
- Communication
- Post Discussion
- What After that
What is the next step in Brain Death Examination?

A 55 year old female was with her children on Thanksgiving day and is brought to hospital unresponsive. CT head was normal at presentation and usual lab studies are normal. Two days later patient is still not waking up, and a neurology consultation is called for brain death examination.
Question: CT head
Question: So What should we do next

- Does not meet the Brain Death Criteria (by US criteria).
- She may do so after sometime ----- But not now.
- So make sure all the pre brain Death Criteria are met.
  - Coma
  - Irreversible, catastrophic whole brain injury is evident.
  - Brain Stem reflexes are absent.
  - Other reasons for the coma have been ruled out (even in case of above).
  - Before you proceed to a Neurologic Exam/Apnea Test/Confirmatory testing).
- Talk to your Attendings before activating Organ donation Agency.
Perception of Conflict

- Organ Donation Agency team and Treatment Team should avoid all contact and perception of collaboration.

- Federal and state law requires the physician to contact an organ procurement organization following determination of brain death.\textsuperscript{4,5}

- Trust in the system is fundamental to the integrity of the system. Any perception of collusion undermines the whole system.
Perception of Conflict.

- Most places allow staff to call organ donation to evaluate patient for organ donation.
- Problems:
  - Organ Donation Engages with family.
  - Organ Donation Engages with staff.
  - Organ Donation Engages with Physician care team.
- Ok to inform:
  - Should not engage with FAMILY/TREATMENT TEAM.
Examination

- What will be the next step in your examination?

- A 19 year old male from Lake Wobegon is brought to ER after his ATV submerged a frozen lake. Patient was in pulseless electrical rhythm (heart beating according to electrocardiogram but no discernable pulse or blood pressure). Patient was cooled. Neurology consult called as he is in coma. Neurology resident examines patient, and reports that he meets criteria for brain death.
Examination
Examination

- Avoid Rush
- Establish Coma
- Rule out other possible causes of coma: Sedating drugs, paralytics, medical conditions.
- Meet all prerequisites.
- Assess Brain Stem and Reversibility.
- Examination is relevant only after all of above has been done.
- Apnea testing --- regimented.
- Second examination.
- Confirm if needed.
- No compromise: You got to get this right.
Ancillary Tests
Cerebral Circulation

- Brain Edema
  - high ICP
    - --- Higher than MAP thus arresting flow.
- Cerebral Angiography (CTA)
- Cerebral scintigraphy Technetium Tc 99m
- Transcranial Doppler
- EEG
Communicating
Brain Death

- A healthcare worker talking to a family states, “We will take your son off of life support now that he has been declared brain dead. If you want to say your goodbyes, please do so now.”
- What is wrong with the statement.
- Avoid Using Brain Death altogether ---- Use “Dead” in your conversations.
- Wait for the actual declaration before discussing anything with the family/friends -- --- Remember patient is alive until pronounced dead.
Communication – Cont.

- Save a life ---- Make a difference.
- Do not create False Hope ---- We as medical professionals get nervous around death and uncertainty.
- Clearly define death
  - Help Family Grieve
  - Alleviate pain of family
- Understand
  - For us another day at work for us.
  - For the family it is 1:1000000 experience that they are not prepared for and nothing we can do can prepare them for this.
Communication – Cont.

- We are here to help family.
- Culture
- Mistrust
- Getting defensive
- Extend yourself.
- Bring your professional integrity along
Never use Brain Death Unless that is the case
Be very crisp and clear when describing states of consciousness
Coma is coma and not brain death.
Your Specificity has to be 110%, when in doubt, patient is not dead!
YOU CAN NEVER BE WRONG.
Be empathetic ---- be human.
State what you can stand behind 100%.
Bring yourself down to layman's terminology ------ Do not quote data and studies.
Brain Death In Adults Compared to Children

**Interval between two evaluations**
Term to 2 mo old, 48 hr
>2 mo to 1 yr old, 24 hr
>1 yr to <18 yr old, 12 hr
>18 yr old, interval optional

**Confirmatory tests**
Term to 2 mo old, 2 confirmatory tests
>2 mo to 1 yr old, 1 confirmatory test
>1 yr to <18 yr old, optional
>18 yr old, optional
Final Thoughts

1. Patient in coma
2. Evidence of Injury: Irreversible, Catastrophic whole brain injury on imaging
3. No obvious metabolic cause, medication or intoxicant to explain this.
4. Neurological Exam – No Brain stem or cerebral function
5. Apnea testing
6. If steps 1, 2, 3, 4 are met and we can not pursue apnea testing, confirmatory test can be used.
7. Communicating with family.
Clinical Context, cont.

- To determine “cessation of all functions of the entire brain, including the brain stem,” physicians must:
  - determine the presence of unresponsive coma
  - determine the absence of brainstem reflexes
  - determine the absence of respiratory drive after a CO$_2$ challenge

- To ensure that the cessation of brain function is “irreversible,” physicians must:
  - determine the cause of coma
  - exclude mimicking medical conditions
  - observe the patient for a period of time to exclude the possibility of recovery
References


4. Title 42 CFR 482.45 (Condition of participation: Organ, tissue, and eye procurement).

5. Title 42 USC § 1320b-8 (Hospital protocols for organ procurement and standards for organ procurement agencies).


7. “Coma and Impaired Consciousness” by Young, Ropper, and Bolton, 1998.