Brain Death: Ongoing Threats

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DISCLOSURES

• I receive research support as PI of R01NS102574-01A1
• I receive research support from Bard Medical, Inc. for the INTREPID Study (NCT02996266)
• I serve as editor-in-chief for Seminars in Neurology
Practice Parameters published in 1995, based on the Uniform Determination of Death Act (UDDA): “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 is made with acceptable medical standards.”

Uniform Determination of Death Act, 12 uniform laws annotated 589 (West 1993 and West suppl 1997)
Variability of brain death determination guidelines in leading US neurologic institutions

ABSTRACT

Background: In accordance with the Uniform Determination of Death Act, guidelines for brain death determination are developed at an institutional level, potentially leading to variability of practice. We evaluated the differences in brain death guidelines in major US hospitals with a strong presence of neurology and neurosurgery to determine whether there was evidence of variation from the guidelines as put forth by the American Academy of Neurology (AAN).

Methods: We requested the guidelines for determination of death by brain criteria from the US News and World Report top 50 neurology/neurosurgery institutions in 2006. We evaluated the guidelines for five categories of data: guideline performance, preclinical testing, clinical examination, apnea testing, and ancillary tests. We compared the guidelines directly with the AAN guidelines for consistencies/differences.

Results: There was an 82% response rate to requests. Major discrepancies were present among institutions for all five categories. Variability existed in the guidelines’ requirements for performance of the evaluation, prerequisites prior to testing, specifics of the brainstem examination and apnea testing, and what types of ancillary tests could be performed, including what pitfalls or limitations might exist.

Conclusions: Major differences exist in brain death guidelines among the leading neurologic hospitals in the United States. Adherence to the American Academy of Neurology guidelines is variable. If the guidelines reflect actual practice at each institution, there are substantial differences in practice which may have consequences for the determination of death and initiation of transplant procedures. Neurology® 2009;70:284-289
Evidence-based guideline update: Determining brain death in adults
Report of the Quality Standards Subcommittee of the American Academy of Neurology

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ABSTRACT

Objective: To provide an update of the 1995 American Academy of Neurology guideline with regard to the following questions: Are there patients who fulfill the clinical criteria of brain death who recover neurologic function? What is an adequate observation period to ensure that cessation of neurologic function is permanent? Are complex motor movements that falsely suggest retained brain function sometimes observed in brain death? What is the comparative safety of techniques for determining apnea? Are there new ancillary tests that accurately identify patients with brain death?

Methods: A systematic literature search was conducted and included a review of MEDLINE and EMBASE from January 1996 to May 2009. Studies were limited to adults (aged 18 years and older).

Results and recommendations: In adults, there are no published reports of recovery of neurologic function after a diagnosis of brain death using the criteria reviewed in the 1995 American Academy of Neurology practice parameter. Complex-spontaneous motor movements and false-positive triggering of the ventilator may occur in patients who are brain dead. There is insufficient evidence to determine the minimally acceptable observation period to ensure that neurologic functions have ceased irreversibly. Apneic oxygenation diffusion to determine apnea is safe, but there is insufficient evidence to determine the comparative safety of techniques used for apnea testing. There is insufficient evidence to determine if newer ancillary tests accurately confirm the cessation of function of the entire brain. Neurology® 2010;74:1911-1918
APPENDIX 2

Checklist for determination of brain death

Prerequisites (all must be checked)
- Coma, irreversible and cause known
- Neuroimaging explains coma
- CNS depressant drug effect absent (if indicated, toxicology screen if barbiturates given, serum level < 10 μg/ml)
- No evidence of residual paralytics (electrical stimulation if paralytics used)
- Absence of severe acid-base, electrolyte, endocrine abnormality
- Normothermia or mild hypothermia (core temperature > 36°C)
- Systolic blood pressure ≥ 100 mm Hg
- No spontaneous respirations

Examination (all must be checked)
- Pupils nonreactive to bright light
- Corneal reflex absent
- Oculocephalic reflex absent (tested only if C-spine integrity ensured)
- Oculovestibular reflex absent
- No facial movement to noxious stimuli at supraorbital nerve, temporomandibular joint
- Gag reflex absent
- Cough reflex absent to tracheal suctioning
- Absence of motor response to noxious stimuli in all 4 limbs (spinally mediated reflexes are permissible)

Apnea testing (all must be checked)
- Patient is hemodynamically stable
- Ventilator adjusted to provide normocarbia (Paco₂ 34–45 mm Hg)
- Patient pressurized with 100% Fio₂ for > 10 minutes to Pao₂ > 200 mm Hg
- Patient well-oxygenated with a PEEP of 5 cm of water
- Provide oxygen via a suction catheter to the level of the carina at 6 L/min or attach 'T'-piece with CPAP at 10 cm H₂O
- Disconnect ventilator
- Spontaneous respirations absent
- Arterial blood gas drawn at 8–10 minutes; patient reconnected to ventilator
- PCO₂ ≥ 60 mm Hg, or 20 mm Hg rise from normal baseline value OR
- Apnea test aborted

Ancillary testing (only 1 needs to be performed; to be ordered only if clinical examination cannot be fully performed due to patient factors, or if apnea testing inconclusive or aborted)
- Cerebral angiogram
- HMPAO SPECT
- EEG
- TCD

Time of death (DD/MM/YY) ______________________________
Name of physician and signature __________________________
More recent data...
Basic Stats

• 508 individual policies obtained

• (likely many policies shared within a health system, so 508 is an underestimate of the total hospitals represented)
Type of Clinician Performing BD Determination

- Mid-Level Provider
- Other
- Appropriate qualified member of medical staff
- Primary + "Another Physician"
- Any licensed physician
- Primary Attending
- Intensivist
- Neurologist, Neurosurgeon or Intensivist or ED Physician
- Neurologist/Neurosurgeon Attending + Primary
- Neurology/Neurosurgery Attending Only

Circle sizes represent the number of occurrences:
- 27
- 65
- 108
- 3
- 31
- 30
- 34
- 6
- 8
- 30

Attending Physician vs. Non-Attending Physician:

- Generalist
- Neurologist/Neurosurgeon
Prerequisites for Clinical Testing

- "Train of Four": 11%
- Absence of Hypotension: 56%
- Absence of Confounding Med Cond.: 74%
- Established Cause: 83%
- Absence of Drugs: 94%

Venn Diagram:
- Acid-Base: 8
- Endocrine: 3
- Electrolyte Disturbance: 3
- Total: 258

Drug Levels Mentioned?
- Yes: 25%
- No: 75%
Apnea Testing Criteria

- # Liters of O2 Specified: 63%
- Absence of Respiratory Effort: 88%
- Pre-Oxygenation Specified: 79%
- Final pCO2 Specified: 69%
  - ≥60mmHg: 55%
  - <60mmHg: 14%
- ABG Prior: 66%
- pCO2 Level Above Baseline Specified: 59%
  - ≥20mmHg: 65%
  - <20mmHg: 12%
- Temperature Prior To Testing Specified: 45%
  - ≥36°C: 65%
  - <36°C: 12%
- Stop if Unstable: 64%

Venn Diagram:
- Hypotension: 14%
- Desaturation: 65%
- Arrhythmia: 12%
- Hypotension and Desaturation: 5%
- Hypotension and Arrhythmia: 1%
- Desaturation and Arrhythmia: 1%
- All three: 1%

Why?
Improving uniformity in brain death determination policies over time

ABSTRACT

Objective: To demonstrate that progress has been made in unifying brain death determination guidelines in the last decade by directly comparing the policies of the US News and World Report’s top 50 ranked neurologic institutions from 2006 and 2015.

Methods: We solicited official hospital guidelines in 2015 from these top 50 institutions, generated summary statistics of their criteria as benchmarked against the American Academy of Neurology Practice Parameters (AANPP) and the comparison 2006 cohort in 5 key categories, and statistically compared the 2 cohorts’ compliance with the AANPP.

Results: From 2008 to 2015, hospital policies exhibited significant improvement (p < 0.005) in compliance with official guidelines, particularly with respect to criteria related to apnea testing (p < 0.009) and appropriate ancillary testing (p < 0.00006). However, variability remains in other portions of the policies, both those with specific recommendation from the AANPP (e.g., specifics for ancillary tests) and those without firm guidance (e.g., the level of involvement of neurologists, neurosurgeons, or physicians with education/training specific to brain death in the determination process).

Conclusions: While the 2010 AANPP update seems to be concordant with progress in achieving greater uniformity in guidelines at the top 50 neurologic institutions, more needs to be done. Whether further interventions come as grassroots initiatives that leverage technological advances in promoting adoption of new guidelines or as top-down regulatory rulings to mandate speedier approval processes, this study shows that solely relying on voluntary updates to professional society guidelines is not enough. Neurology® 2017;88:1–7
The majority of institutions (71%) have updated their policies at a date after the June 2010 update to the AANPP, while 16% did not, and 13% made no mention of revision date, suggesting most institutions had an opportunity to review the official guidelines prior to adopting their current policies.
Prerequisites for testing

The majority of 2015 policies (95%) required prerequisites, and named individual prerequisites at a consistently higher rate than in 2006 (e.g. 89% of 2015 policies looked for cause of coma vs only 63% in 2006)
Prerequisite absence of confounding disorders

[A] The absence of confounding medical conditions were specified more frequently in 2015 than 2006 for electrolyte disorders (92% vs 72%), acid-base disorders (92% vs 45%), and endocrine disorders (80% vs 42%). [B] Most commonly in the 2015 policies, the three conditions were named together as a group of possible confounders, with a smattering of other disorders, such as nutritional deficits, listed additionally.
Clinical examination compliance with AANPP, 2015 vs 2006

[A] to [H] show consistent, good compliance to the majority of the clinical examination, with additional specificity for pupil size in 45% of policies; [I] to [K] highlight areas of notably poor adherence in 2006 & 2015.
Apnea testing criteria appear to trend towards less variability from 2006 to 2015, with a notably higher proportion of policies requiring ABGs before beginning apnea testing (89% vs 66%) and a pCO$_2$ rise of 20mmHg above baseline for the test to qualify as positive (76% vs 39%). However, wide variability is seen in the recommended liters/min rate of supplemental oxygen.
Jahi McMath, California, 2013-18

Aden Hailu, Nevada, 2015-16

A Child, United Kingdom, 2015

Israel Stinson, California, 2016

Allen Callaway, Montana, 2016

Mirranda Grace Lawson, Virginia, 2016

Alex Pierce, California, 2016

Taquisha McKitty, Ontario, 2017-18

Shalom Ouancouver, Ontario, 2017-18

Areen Chakrabarti, Pennsylvania, 2018

Jayden Auyeung, Pennsylvania, 2018
Important Peds – Adults Guideline Differences

PEDS
• Minimum temp 35C
• 2 exams
• Observation period, varies by age
• Some procedural details lacking
• Different ancillary tests, indications
• Multiple different age groups with different rules

ADULTS
• Minimum temp 36C
• 1 vs. 2 exams
• No observation period (sort of)
• Most procedural details present
• Different ancillary tests, indications

• Aspects can be tightened for both groups of patients.
• Most aspects can be unified as general principles that pertain to both groups.
• There will be a natural “carve out” for peds (e.g. BP for age, cranial physiology below 2 years of age, etc.)
Guidelines for the determination of brain death in children

Task Force for the Determination of Brain Death in Children

Determining brain death in adults

Eckso F. M. Wijdicks, MD

Evidence-based guideline update: Determining brain death in adults

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What are we doing to improve the field?

• Educational/training endeavors
  • Online training and certification
  • Simulation training
  • “Champions”

• Creation of a national/international standard
  • Lobby at a national level for ONE STANDARD
  • Nevada is already there

• AAN position statement on accommodation and pregnancy

• Potential merging of adult and child guidelines

• Brain Death Toolkit: https://www.pathlms.com/ncs-ondemand/courses/1223
  • Or just search “brain death toolkit”

• World Brain Death Project
World Brain Death Project

Objectives:

• To consolidate and summarize the knowledge base surrounding the concept and practice of brain death, with a goal of establishing international professional consensus regarding the underlying principles and clinical practice.

• To serve as a framework of understanding for the current model of brain death, and help guide future developments in the field.

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### Topics:

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Contributors

Collaborating Organizations

1. European Society of Intensive Care Medicine (ESICM)
2. China Brain Injury Evaluation Quality Control Centre
3. International Pan-Arab Critical Care (IPACCMS)
4. Neurocritical Care Society
5. Australia-New Zealand Intensive Care Society (ANZICS)
6. World Federation of Critical Care Nurses (WFCCN)
7. World Federation of Neurology (WFN)
8. World Federation of Neurosurgical Societies (WFNS)
9. World Federation of Pediatric Intensive & Critical Care Societies (WF PICCS)
10. World Federation of Societies of Intensive and Critical Care Medicine (WFSICCM)
**Process**

World Congress of Intensive and Critical Care Medicine
Nov 2017
Rio, Brazil

Planning  Literature search  Review of evidence  Drafting of consensus statements  Consensus forum  Revisions  External review  Publication  Knowledge translation

AAN  ESICM  IPACCCMS  NCS  WFCCN  WFN  WFNS  WFPICCS  WFSICCM