Brain death determination in the pediatric population

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By the end of the talk...
- “Brain death” is a syndrome
- Cite the components of a brain death determination
- Why we need brain death criteria
- How the definition of death has evolved
- Ciba Foundation Symposium, Harvard Criteria, the President’s Commission

Disclaimers
- The information used to prepare this presentation is current. This topic, however, is a moving target. Check the rules in your State and hospital.
- The opinions expressed during this talk are mine. They do not represent those of:
  - Nationwide Children’s Hospital
  - The Ohio State University
  - National Public Radio or other liberal bastions

What is death?
1) Cessation of cardio-respiratory functions “cardio-respiratory death”
2) Cessation of all brain functions “brain death”
What is “brain death”?

- It is a syndrome with three cardinal findings:
  - Coma
  - Apnea
  - Absence of brainstem reflexes

The bottom line (AAP 1987)
A child is brain dead when...

- The child is in a coma and apneic
- A cause for the coma has been identified, and reversible conditions have been treated
- The child has absent brainstem reflexes
  - Absent pupillary reflex
  - Absent oculocephalic response
  - Absent corneal reflex
  - Absent cough, gag, sucking, and rooting reflexes

The bottom line (cont)

- The child is not hypothermic or hypotensive
- The child does not have spontaneous or induced movements excluding miotactic reflexes
- The exam remains unchanged throughout the “observation periods”
- Consider ancillary tests

The bottom line (cont)

- Observation periods and ancillary tests
  - 7 days - 2 months: 2 exams & EEGs 48 h apart
  - 2 – 12 months: 2 exams & EEGs 24 h apart
  - One year and older: 2 exams 12 h apart; EEG and angiogram are optional
The bottom line at NCH (as of 6/06, currently under review)

- Principles are the same as per AAP 1987
- Observation periods and corroborating tests:
  - Less than 7 days of life: 2 exams 24 - 48 hours apart or longer, consider ancillary tests
  - 7 days - 12 months: 2 exams 24 - 48 hours apart, consider ancillary tests
  - 1 year or older: 2 exams 12 - 24 hours apart, no guideline on ancillary tests

Ancillary tests
- Cerebral radionuclide scan
- Arteriogram
- EEG
- Need Neurology or Neurosurgery consultation (as deemed appropriate)

Who can or cannot determine pediatric brain death at NCH?

- Can
  - The patient’s attending of record, critical care specialist, neurologist, neurosurgeon
    - Attending or resident?
- Cannot
  - Physicians involved in organ transplantation / procurement

Three recommendations

- Document, Document, Document
  - Etiology of the irreversible condition
  - Patient’s temperature (> 32.2°C)
  - CNS-active medications
  - Absence of brainstem reflexes
  - Absence of motor response to pain
  - Apnea with PCO2 > 60 mm Hg
  - Justify use or not of ancillary test
  - Repeat exam
We now join the philosophical portion of this presentation already in progress...

Why do we need criteria to diagnose death?
- Because it is not that easy!

1/10/08

Why do we need criteria for brain death?
- For transplantation; not for discontinuing therapy
- Brain death has never been a prerequisite for withdrawal of supportive care
When are you really dead?

It depends who and when you ask!

Biblical times

Death = not breathing

“...and the Spirit (breath) of God moved upon the face of the waters” Genesis

Brief historical perspective

Ancient Greece

Death = no heart beat

Rome 1600's
Paulus Zacchias
Physician to Pope Innocent X
Father of Forensic Medicine

“Prior to putrefaction, no sign is reliable to distinguish between life and death”
France 18th century

Antoine Louis
- Military surgeon and physiologist
- Co-inventor of the guillotine

“The onset of rigor mortis is sufficient sign of death”

19th century

- Death = no heartbeat and not breathing
  - Mirror test
  - Candle test
  - Bleeding test

18th century: death and resuscitation

- British humane societies
  - Taught physicians methods to revive the “drowned and suffocated”
    - Smelling salts
    - Vigorous shaking
    - Artificial respiration
    - Electrical shocks

If we can diagnose death, can we reverse the process?
18th century: death and resuscitation

Galvanism: use of electricity to "revive the dead"

Early thoughts on transplantation

Galvanic battery

Limb transplantation miracle by Saints Cosmas and Damian (circa 250 AD)
Patron Saints of medicine, doctors and pharmacists; feast day Sept 26

No good deed goes unpunished!

The beheading of Cosmas and Damian, Fra Angelico, circa 1440
19th century and transplantation

- 1818 Mary Shelly publishes “Frankenstein; or the modern Prometheus”

- Influences:
  - Of her 4 children only one survived to adulthood
  - Read Aeschylus’ “Prometheus bound”
  - Married to Percy Shelly author of “Prometheus unbound”

Prometheus was a Titan!

Pandora

- The “all-endowed”
- The “giver of all”
- The “beautiful evil”

Frankenstein and transplantation

- Victor Frankenstein creates a being made out of human parts and “brings life to his creation” (hence, Prometheus)
- The monster becomes a murderer as punishment to the scientist for taking on God’s ability to give life

Even Walt Disney became involved!!

- In 1883 Carlo Collodi published “The adventures of Pinocchio”
- Another man-made being on whom life is bestowed (and he was also naughty)
- And his father was Geppetto just like that of Prometheus!

Fast-forward to the mid-20th century...

- 1954 kidney donation between identical twins
- 1962 first kidney transplantation from a “cadaver”
- 1963 first kidney transplantation from a “brain dead” donor

Ciba Foundation Symposium: Ethics in medical progress with special reference to transplantation (1966)

- Concepts for discussion
  - Progress in medicine brings along ethical questions that concern the community
  - Removal of an organ poses a danger to the donor, immediate and long term
  - Many people are maintained alive by machines even if they will never regain independent existence
    - When can the machines be switched off (and their organs harvested)?
  
- What is needed is a new definition of death!
  
  And “Brain Death” was born
Donor has endured severe cranio-cerebral injuries and has:
- Bilateral midriasis
- Absent reflexes
- Apnea (off ventilator for 5 minutes)
- Falling blood pressure requiring pressors
- Flat EEG

The kidney donor was involved, the heart donor is committed!

Heart transplantation:
The Harvard criteria (1968)

- 1967 first cardiac transplantation from a “donor with a beating heart and brain death”: Dr. Barnard, South Africa
- 1968 first cardiac transplantation in the US: Dr. Shumway
- 1968: 108 heart transplants!
- Harvard University established the "Harvard Brain Death Committee"

Purposes:
- Establish that irreversible coma ought to be a new "criterion for death"
- Establish that defining death and pronouncing a patient dead are exclusive responsibilities of physicians

The Harvard criteria (1968)

- Accomplishments:
  - In summary: “brain dead” equals “dead”
    A person is dead when the entire brain, brainstem included, have permanently ceased to function
  - To avoid appearance of self-interest, death determination should not involve either the treating physician of record or members of the transplant team
The Harvard criteria (1968)

- Unresponsiveness (coma)
- Temperature > 32.2°C
- Absence of depressant drugs
- No spontaneous movements
- Apnea – off respirator for 3 minutes
- No reflexes:
  - pupils fixed and dilated, no corneal responses, no cough or gag, no deep tendon reflexes
- Isoelectric EEG
- All of the above must be unchanged over 24 hours


"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 brainstem, is dead.

A determination of death must be made in accordance with "accepted medical standards"

Other criteria

- State- and institution-specific criteria

Why do we need brain-death criteria? Farrell and Levin, 1993

- Humans = two entities
  - Biological entity, similar among humans
  - The person or individual
Death:
- Demise of the biological entity OR
- Loss of personhood
- If the biological entity is similar among humans, loss of personhood is what matters

Farrell and Levin, 1993

"What is lost at the time of death that is significant to man is personhood"

For organ harvesting and transplantation we need criteria to determine when "loss of personhood" has occurred while the patient is still hemodynamically stable

Why do we have specific criteria for children? myth vs. reality

AAP 1987
- Premature children and those who are less than 7-days-old:
  - Limited data
  - Brain is "less susceptible" to hypoxia
  - Most insults are partial asphyxia
  - Less likely to have impairment of cerebral perfusion
Why do we have specific criteria for children? myth v. reality

- In newborn:
  - Difficult to determine cause of coma (prematurity, congenital, metabolic)
  - Cause of "coma" may be related to mother
- Testing is based on brainstem reflexes which may not be developed
  - Moro response: 28-32 weeks
  - Corneal responses: 28-32 weeks
  - Sucking and rooting: 32 weeks
  - Grasp reflex: 34-36 weeks
- EEG may be "immature"; have artifacts

Ashwal 1993 "With the use of confirmatory tests, including an isoelectric EEG or absent CBF, the observation period can be reduced to 1-2 days"

Ancillary tests to fulfill the criteria of brain death

- **EEG**
  - At least 8 electrodes
  - Sensitivity 2 uv/mm
  - Evaluate photic stimulation, response to pain
  - Isoelectric for 30 minutes

The problem of looking for the "neuron in the haystack"

Ancillary tests to fulfill the criteria of brain death

- **Cerebral arteriogram**
  - Absence of blood flow on four-vessel cerebral arteriogram is evidence of brain death
- **Radionuclide brain scanning**
  - Absence of intracranial signal is confirmatory of brain death
- Good tools to use in a patient in medication induced coma
So, what is the gold standard?

The clinical exam!

How good are we at following AAP’s 1987 guidelines?

- Survey of PICUs (Mejia & Pollack 1995)
  - Significant variability in the criteria used to diagnose brain death
  - Incorrectly done apnea test
  - No ancillary testing done when needed

- Survey of 18 pediatric hospitals (Chang et al. 2002)
  - Only 4 hospitals faithfully follow guidelines
  - Most violations: trauma and neurosurgeons

Brain death criteria worldwide

- US and Canada use the same definition
  - Florida & Virginia: specialist in “neurosciences”
  - Alabama, California, Connecticut, Florida, Iowa, Kentucky, Louisiana, Virginia: two physicians
  - Alaska & Georgia: Nurse can do first exam
  - New Jersey & New York: family may refuse exam based on religious objections
Brain death criteria worldwide

- UK: clinical exam is enough
- Rest of Europe: ancillary tests are required
  - Scandinavia: arteriogram required
- Central and South America: ancillary tests are optional
- Africa: few countries have guidelines