Neurologic Determination of Death

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Format

• Definition of Brain Death
• Historical Perspectives
• International consistency / inconsistency of the definition
• How errors can be avoided
• Confounding factors
• The role of ancillary testing
• Questions / discussion
Defining Death

• Sounds easy
• Pathway from life to death is a continuum
• For the purposes of organ donation we try to pinpoint the exact point of no return

• Controversy remains, yet high? international consistency exists
Dead Donor Rule

• Universally accepted concept

• Organ donors must be dead prior to donation
Criteria for a Diagnosis of Death

**Cardio-respiratory criteria**
- Irreversible cessation of cardiac and respiratory functions
- These lead to brain injury
- Auto-resuscitation?

**Neurological criteria**
- Catastrophic brain injury leading to irreversible cessation of clinical brain functions
- Specifically: consciousness, brainstem reflexes, breathing
- Confounders?
- Ancillary testing?
- “Whole brain death?”
Neurologic Determination of Death

FUNCTIONAL DIAGNOSIS!!!
Physiology of Brain Arrest

ICP Increase  [MAP increase to maintain CPP (tachycardia + hypertension)]

↓

Midbrain Ischemia  [Parasympathetic activation (apnea, bradycardia, hypotension)]

↓

Pontine Ischemia  [More sympathetic (bradycardia / tachycardia, hypertension)]

↓

Medulla Ischemia  [unopposed sympathetic (tachycardia, vasoconstriction)]

↓

Pituitary and hypothalamic ischemia  [thyroid, adrenal dysfunction, decrease in Vasopressin]
"Brainstem death is the infratentorial consequence of a supratentorial catastrophe"
Historical Perspectives

- 1959 “Coma Depasse” Mollaret and Goullon
- 1968 Harvard Criteria for Brain Death

A Definition of Irreversible Coma

Report of the Ad Hoc Committee of the Harvard Medical School to Examine the Definition of Brain Death

Characteristics of Irreversible Coma

An organ, brain or other, that no longer functions and has no possibility of functioning again is for all practical purposes dead. Our first problem is to determine the characteristics of a permanently nonfunctioning brain.

A patient in this state appears to be in deep coma. The condition can be satisfactorily diagnosed by points 1, 2, and 3 to follow. The electroencephalogram (point 4) provides confirmatory data, and when available it should be utilized, in situations where for one reason or another electroencephalographic monitoring is not available, the absence of cerebral function has to be determined by purely clinical signs, to be described, or by absence of circulation as judged by standstill of blood in the retinal vassals, or by absence of cardiac activity.

1. Unresponsiveness and Unresponsivity—There is a total unresponsiveness to externally applied stimuli and inner need and complete unresponsivity—our definition of irreversible coma. Even the most intensely painful stimuli evoke no vocal or other response, not even a grim, withdrawal of a limb, or quickening of respiration.

2. No Movements or Breathing—Observations covering a period of at least one hour by physicians is adequate to satisfy the criteria of no spontaneous muscular movements or spontaneous respiration or response to stimuli such as pain, touch, sound, or light. After the patient is on a mechanical respirator, the total absence of spontaneous breathing may be established by turning off the respirator for three minutes and observing whether there is any effort on the part of the subject to breathe.
International Consistencies / Inconsistencies

Remarkable Consistency in “General Principles”
- Unresponsiveness from a KNOWN cause
- Lack of brainstem reflexes
- Apnea

Many Differences in Implementation
- Institutional protocols
- Absence of spinal reflexes sometimes required
- Apnea test criteria
- Inclusion of ancillary testing
- Inclusion of EEG
- Assessing physician specialty
- Duration of observation
Is an International Brain Death Consensus Achievable?

Desirable – would enhance public confidence

**Many medical and societal barriers**
1. Acceptance of brain death as death
2. Legal standards
3. Religious challenges
4. Transplantation requirements
5. Medical practice variations
6. Ancillary testing – availability discrepancies
Avoiding NDD Errors

• Ruling out confounders
• CT scan consistent with the cause of death
• Use of a checklist for the clinical criteria

• Spinal reflexes
• Locked-in syndrome

• Low threshold to consult a more experienced clinician
• Failing that, ancillary testing
Confounders

• Severe electrolyte abnormalities
• Severe acid-base abnormalities
• Endocrine imbalances
• Hypotension
• Drug intoxication
• Neuromuscular blocking agents

• MUST HAVE A DIAGNOSIS CONSISTENT WITH THE CLINICAL PICTURE!
NDD Confounding Factors

- Shock
- Hypothermia
- Metabolic Disorders
- PN or NM Dysfunction
- Drug Intoxication

Pediatric (n=11)
Adult (n=26)
Spinal Reflexes

- Are uncommon
- Do not resemble decorticate or decerebrate movements

- Triple flexion responses
- Finger flexion or extension
- Head turning
- Slow arm lifting

- If doubt exists, consult

- Error on the side of conservatism
Locked-In Syndrome

- From a localized process (i.e., Basilar artery embolus)
- Destruction of the base of the pons
- No limb movement, grimacing or swallowing
- Upper rostral mesencephalic structures remain intact
- Consciousness, voluntary blinking and vertical eye movements preserved
Intoxications

Intoxication → Process that causes catastrophic brain injury → Neurologic declaration
Iatrogenic Intoxications

• Patient has a cause consistent with an NDD diagnosis

• Hepatic / renal dysfunction
• Opiate / benzodiazepene infusions for 48 hrs, just stopped

• When may this patient be safely declared by neurologic criteria?
Ancillary Testing

• Does not remove the need for clinical diligence
• Does not remove the need for clinical examination

• How to interpret: “indeterminate scans”, “trickle” of flow
## Methods of Assessment for NDD in Ontario – FY 2014-15

<table>
<thead>
<tr>
<th>Method</th>
<th>Province</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical with Apnea</td>
<td>243 (86%)</td>
</tr>
<tr>
<td>Clinical Ancillary Testing</td>
<td></td>
</tr>
<tr>
<td>CT Angio</td>
<td>22 (8%)</td>
</tr>
<tr>
<td>CBF(Radionuclide)</td>
<td>17 (6%)</td>
</tr>
<tr>
<td>Four Vessel Angio</td>
<td>0 (0%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>282</strong></td>
</tr>
</tbody>
</table>

Date: 1st April, 2014 – 31st March, 2015
Source: iTransplant
Preliminary Data
1. Brain death is a *functional* definition

2. Brain death is predominantly a *clinical* diagnosis

3. Beware of confounders

4. Error on the side of conservatism

5. When in doubt – consult someone experienced.
References

6. CMA Policy: Organ and Tissue Donation and Transplantation Update 2014
References