Determination of Death Practices in Intensive Care

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Thank you for Support

• CHEO RI
• OHRI
• CCCTG
• CCCTG review
• Loeb Research Consortium for Organ and Tissue Donation
• CCCS

CIHR
PSI
CHEO RI
Rationale for study

• Donation after *Circulatory* Determination of Death
  – Supported by most professionals and public
  – Still discomfort and controversy
    • 1. determination criteria
    • 2. cessation of function
    • 3. irreversibility
    • 4. autoresuscitation

• Risk of Violating the Dead Donor Rule
  – has created the need to clarify the medical determination of death after *cardiac* arrest
DDePICt
Determination of Death Practices in Intensive Care

Project Objectives
1. To describe the current understanding and practice of the determination of death after cardiac arrest
2. To describe and evaluate the circulatory and neurologic determinants of death after cardiac arrest using non-invasive and invasive monitoring
3. To describe the potential for autoresuscitation
4. To develop and implement standards for the determination of death after cardiac arrest
I. Literature review of determination of death after cardiac arrest and autoresuscitation

II. Survey of Intensive Care Physicians current practice of determination of death after cardiac arrest

III. Pilot observational pilot study of the physiologic changes that occur with death after cardiac arrest

IV. Multi-centre prospective observational study using non-invasive and invasive monitoring techniques
Phase V.
Guideline Development and Implementation

Inform policy and develop guidelines for the determination of cardiac death for the purposes of organ donation after cardiocirculatory death
Feasibility Study Observing Physiologic Changes that Occur with Death after Cardiac Arrest following WLST
Research Question

• What are the physiological determinants of death after cardiac arrest following WLST in critical care patients?
How to Answer this Question?

• Need to collect data during the dying process after cardiac arrest.
• Could we do this?

• An observational *pilot* study of the physiological changes that occur during the dying process.
Primary Objective

• **Feasibility**
  – recruitment,
  – consent rates,
  – and protocol compliance

• Pilot studies in 5 *Canadian ICUs*
  – 4 adult, 1 pediatric

• **45 subjects** in total...or 12 months
Secondary Objectives

• Determine most appropriate monitoring parameters of key cardiocirculatory and neurological measures.

• Determine the time intervals of disappearance of key cardiocirculatory measures.

• Describe the frequency of autoresuscitation.

• Describe other key factors that may affect feasibility, i.e. bedside staff satisfaction.
Inclusions

- Admitted to ICU
- Patient ≥ 1 month
- Agreement from health care team
- Consensual agreement to WLST and anticipation of imminent death
- Have the following:
  - Continuous ECG, Art Line and $O_2$ sat monitoring
- Informed consent from substitute decision maker

Exclusions

- Cannot be a candidate for organ donation
- Cannot be declared dead using neurological criteria (NDD)
- Cannot have functioning pacemaker
Data Collected – 12 months

• Physiological Variables
  – $O_2$ sat, ECG, Arterial BP, EEG*
  • Collected continuously from WLST to 30 min after declaration of death.
  • Time period of 30 min prior to and 30 min after declaration of death saved to be analyzed

• NO INTERVENTION

• Clinical Death Determination Checklist
• Staff Satisfaction Questionnaire
Monitoring after WLST

- Adjudicator review:
  - Cessation of ECG activity.
  - Cessation of ABP activity.
  - Any reappearance of activity
Primary Objective

• **Feasibility**
  - Recruitment – 91% (41/45) of patients enrolled
  - Consent rate – 87%
  - Protocol compliance – 76%

![Bar chart showing the number of patients screened, enrolled, and refused at different study sites.](chart.png)
<table>
<thead>
<tr>
<th>Reason</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
<th>Site 5</th>
<th>ALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transferred out of ICU</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Age &lt; 1 month</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Refusal by physician +/- or healthcare team</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>No consent from SDM or LG *</td>
<td>1</td>
<td>6</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>17*</td>
</tr>
<tr>
<td>No WLST or death not imminent</td>
<td>11</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>No pulse oximeter</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>No ECG</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>No arterial BP</td>
<td>4</td>
<td>10</td>
<td>9</td>
<td>6</td>
<td>2</td>
<td>31</td>
</tr>
<tr>
<td>Organ donation by NDD or DCD</td>
<td>5</td>
<td>9</td>
<td></td>
<td>18</td>
<td>2</td>
<td>34</td>
</tr>
<tr>
<td>Determined dead by neurological criteria</td>
<td>1</td>
<td>9</td>
<td></td>
<td>11</td>
<td></td>
<td>21</td>
</tr>
<tr>
<td>Pacemaker on</td>
<td></td>
<td>2</td>
<td></td>
<td>2</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Missed patient*</td>
<td>2</td>
<td>6</td>
<td>8</td>
<td>19</td>
<td></td>
<td>35</td>
</tr>
<tr>
<td>Protocol Violations</td>
<td>Count (Percentage)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>--------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did not meet inclusion/exclusion criteria</td>
<td>2 (5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitors removed prior to declaration of death</td>
<td>1 (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem with ECG, O2 saturation or arterial line</td>
<td>2 (5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss of data during transfer to central monitor</td>
<td>2. (5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>5 (12)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Survey Question</td>
<td>N (%  )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
<td>---------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Believe study is important</td>
<td>51 (69)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interfered with how I performed my duties</td>
<td>5 (7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Felt comfortable leaving monitors in place</td>
<td>59 (80)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Felt comfortable caring for study patient</td>
<td>67 (91)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Did we achieve our Primary Objective?

• **Feasibility**
  – Participation
  – Consent
  – Data collection
  – YES!
Secondary objectives - Data collected

• Therapies in place at WLST
• Interventions after WLST initiated
• Clinical Autoresuscitation
• Checklist of tests used to determine death
• Satisfaction
• Monitored waveform data
  – Cessation of ECG, ABP, pleth activity
  – Resumption of activity
<table>
<thead>
<tr>
<th>Demographics &amp; Patient Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender - Male - N (%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pediatric Site, Months (N=4) - Median (Min,Max)</td>
</tr>
<tr>
<td>Adult Sites, Years (N=37) - Median (Min,Max)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Illness Severity on Admission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pediatric Site - PRISM III Score (N=4) - Median (Min,Max)</td>
</tr>
<tr>
<td>Adult Sites - APACHE Score (N=37) - Median (Min,Max)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Most Common Primary Reason for Admission</th>
</tr>
</thead>
<tbody>
<tr>
<td>(N = 41)</td>
</tr>
<tr>
<td>Cardiac condition</td>
</tr>
<tr>
<td>Neurological condition</td>
</tr>
<tr>
<td>Infection/Sepsis</td>
</tr>
</tbody>
</table>

NO Reports of clinical autoresuscitation.
### Diagnostic Tests Used to Determine Death
(N=39)

<table>
<thead>
<tr>
<th>Test</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent heart sounds by auscultation</td>
<td>37 (95)</td>
</tr>
<tr>
<td>Absent palpable pulse</td>
<td>34 (87)</td>
</tr>
<tr>
<td>Absent pulse by audible doppler</td>
<td>1 (3)</td>
</tr>
<tr>
<td>Absent BP by non-invasive monitoring</td>
<td>13 (33)</td>
</tr>
<tr>
<td>Flat arterial line tracing</td>
<td>29 (74)</td>
</tr>
<tr>
<td>Pulseless electrical activity</td>
<td>15 (39)</td>
</tr>
<tr>
<td>Flat ECG tracing</td>
<td>30 (77)</td>
</tr>
<tr>
<td>Absent breath sounds by auscultation</td>
<td>35 (90)</td>
</tr>
<tr>
<td>Absent pulse oximetry</td>
<td>31 (80)</td>
</tr>
<tr>
<td>Unresponsiveness to painful stimuli</td>
<td>20 (51)</td>
</tr>
<tr>
<td>Fixed and dilated pupils</td>
<td>29 (74)</td>
</tr>
<tr>
<td>Other</td>
<td>5 (13)</td>
</tr>
<tr>
<td>Tests repeated</td>
<td>3 (8)</td>
</tr>
<tr>
<td>Confirmed by 2nd physician</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>
Description of monitored activity after WLST

ECG and ABP activity

- 33/41 patients had both ECG and ABP waveform data that was reviewed by a minimum of 3 adjudicators.

- Any form of activity was documented, regardless of scale, quantity, quality, or clinical relevance.

- At times, difficult to interpret artifact, activity, and meaningful activity.

- Focus on “activity” versus “function”
ECG activity

- In 3/33 patients, ABP and ECG *activity stopped* at the same time.

- In 5 patients, ECG persisted, *intermittently*, after absence of ABP activity.
  - Median of *11 minutes 11 seconds* (range, 37 seconds-36 minutes 29 seconds) after absence of ABP activity.

- In 25 patients, ECG persisted, *continuously*, after absence of ABP activity.
  - Median of *3 minutes 10 seconds* (range 0-38 minutes) after absence of ABP activity.
ABP activity

- 30/33 patients had absence of ABP prior to absence of ECG activity (3 at the same time) without recurrence of activity

- 3 patients had identification of ABP activity after absence of ≥60 seconds
Examples: absence of ECG and ABP

Case 3
Case 3 – absent ECG and ABP at 16:23:00
Case 3 – ECG and ABP activity at 16:24:15
Case 3 – absent activity for remaining duration
5 episodes of ABP activity after absence of ≥60s

Absence for minimum of 60 seconds

Absence continues until end of monitoring

```
case 1
62 172 0

case 2
80 1 89 35

case 3
60 30 75 40
```
EEG Activity

• All 4 patients had EEG findings consistent with coma at the time of WLST.

• In 3 patients, isoelectric EEG occurred prior to cessation of ECG and ABP. No return of EEG activity was noted.

• In one patient, delta and theta waveform bursts on EEG persisted following the cessation of both ECG and ABP.
The EEG at WLST demonstrated burst suppression with bursts of delta and
The EEG became isoelectric 17 minutes after WLST (EKG artifact)
return of ECG and ABP (<2mins) for 40 seconds, however, the EEG remained isoelectric
Case example 2

Infrequent single delta wave bursts after ECG cessation.

This unidentified waveform activity, which may be artifactual in nature, persists up until 9 mins after absence of ABP.

Muscle, cardiac, movements, sweat, 60Hz factor.
Summary- it is feasible

- Bedside staff and patient families had minimal objections to research during the dying process, resulting in high recruitment and consent rates
- Collection of ECG, ABP and EEG data during the dying process was possible

Lessons learned
- Artifact, activity, and meaningful activity
- Definitions of cessation, resumption, and autoresuscitation
- Standard electronic platform for data capture and review
The most commonly reported tests to confirm death were absent heart sounds by auscultation, absent palpable pulses, and absent respirations but no single test was done consistently.

In a majority of patients (30/33), ECG activity continued (max of 38 minutes) after the absence ABP activity.

In 3 patients, ABP waveform activity was identified following cessation of at least 60 seconds. This ABP activity persisted for 1–172 seconds. There was no identification of ABP activity after 89 seconds of absence.

In 3 patients, isoelectric EEG occurred prior to cessation of ECG and ABP. No return of EEG activity was noted. In one patient, delta waveform bursts on EEG persisted.

Pilot study findings support current DCD practices.
Next steps:
Multicentre, international, observational study

- To describe the current understanding and practice of the determination of death after cardiac arrest
- To evaluate and describe the determinants of death after cardiac arrest using non-invasive and invasive monitoring technology
- To determine the incidence and relevance of autoresuscitation
- To develop guidelines, inform policy and implement standards for the determination of cardiocirculatory death

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Pilot: Co-investigators/Collaborators

- Andrew Baker
- Jane Chamber-Evans
- Jocelyn Downie
- Jan Friedrich
- Jim Kutsogiannis
- Lauralyn McIntyre
- Franco Momoli
- Karine Morin
- Tim Ramsay
- Andrew Seely
- Bryan Young
- UH-Loretta Norton
- OH-Irene Watpool, Michelle Dickie, Amanda Van Beinum
- SMH-Orla Smith, Jane Topolovec-Vranic, Julia Lee, Yoon Lee, Kerri Porretta, Marlene Santos
- UAH-Pat Thompson, Kirby Scott, Kelli Pearce
- CHEO-Roxanne Ward

London Health Sciences Centre
Ottawa Hospital (General)
St Michaels (Toronto)
Alberta University (Edmonton)
Children’s Hospital of Eastern Ontario
<table>
<thead>
<tr>
<th>CANADA</th>
<th>US</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrew Baker</td>
<td>AM Guerguerian</td>
<td>Tom Nakagawa</td>
</tr>
<tr>
<td>Stephen Beed</td>
<td>Maureen Meade</td>
<td>Sam Parnia</td>
</tr>
<tr>
<td>Jane Chamber-Evans</td>
<td>Lauralyn McIntyre</td>
<td>Paul Shore</td>
</tr>
<tr>
<td>Jennifer Chandler</td>
<td>Franco Momoli</td>
<td></td>
</tr>
<tr>
<td>Christopher (Chip) Doig</td>
<td>Karine Morin</td>
<td>Christian Brailsford</td>
</tr>
<tr>
<td>Jocelyn Downie</td>
<td>Tim Ramsay</td>
<td>Dale Gardiner</td>
</tr>
<tr>
<td>Geoff C Green</td>
<td>Steven Reynolds</td>
<td>Paul Murphy</td>
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<tr>
<td>Ashvini Gurshaney</td>
<td>Andrew Seely</td>
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<tr>
<td>Jan Friedrich</td>
<td>Sam D Shemie</td>
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<tr>
<td>Christophe Henry</td>
<td>Irene Watpool</td>
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<tr>
<td>George Isac</td>
<td>Serafettin Yildirim</td>
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<tr>
<td>Stephane Langevin</td>
<td>Bryan Young</td>
<td></td>
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<tr>
<td>Jim Kutsogiannis</td>
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</tr>
</tbody>
</table>
Thank you

"elucidate the natural history of cessation of physiological function after the removal of life support in those expected to die."

Objective research can inform the discussion about “death” with descriptive physiologic data