Short- and Long-Term Neurologic Outcomes of Cardiac Arrest

Romergryko G. Geocadin, MD
Neurosciences Critical Care Division
Departments of Neurology, Anesthesiology
Critical Care, Neurosurgery, and Medicine
Baltimore, MD
rgeocad1@jhmi.edu
Questions

- What are the primary (neuro) short and long-term health outcomes of out-of-hospital cardiac arrest?
- What factors affect cardiac arrest outcomes?
- What are the most significant barriers to improvement in cardiac arrest outcomes in these populations?
- What current and emerging public health interventions, treatments and therapies can improve survival rates in the general population, as well as subgroups of the cohort?
- What do you perceive to be the top 3 challenges or knowledge gaps in this area, and what are your top three recommendations for improving health outcomes from cardiac arrest?
Historical: Survivors and Functional Outcome

Figure 47.2. Mortality/survival and cause of death in comatose survivors of cardiac arrest (Brain Resuscitation Clinical Trial I [BRCT I], n = 262; Brain Resuscitation Clinical Trial II [BRCT II], n = 516).

BRCT I and II trials
Neuropathology of Cardiac Arrest: Selective Vulnerability

**Vulnerability**
- CA1 and CA4 of Hippocampus
- Middle Laminae of the Neocortex
- Amygdala
- Cerebellar Vermis
- Caudate Nucleus
- Parts of substantia nigra
- Thalamic Reticular Nucleus
- Periaqueductal nuclei
- Certain brainstem nuclei

*Blomquist & Wieloch, JCBFM 1985; Smith, Auer, Siesjo Acta Neuropathol*

**Simplified function**
- Memory/Learning
- Awareness/ Cortical Function
- Emotions/Behavior Integration
- Coordination
- Movement
- Movement
- Complex /Arousal
- Complex /Arousal
- Multiple function

From W. Longstreth 2000

Selective vulnerability: Selective Response to therapies?
Short Term Outcome: Death and Arrest Parameters

Dichotomous outcomes

Survival and time of death

Awakening and time of awakening

WLST preceding Death:
43% Peberdy NRCPR Study
59% Rosetti study
62% Bouwes study
82% Fugate study
81% Samaniego study


86/162 died
61/162 "brain cause"
50/162 WLST
47/162 died in ICU
4/162 Confirmed braindeath
19/47 Resp failure
13/47 Circ Failure

Dragancea, et al 2013

Not reliable prognosticator of neuro recovery:
Duration of arrest/CPR Pre-arrest & intra-arrest factors
Neumar, et al 2008
Wijdicks, et al 2006

7/9/2014
Consciousness: Key to Meaningful Recovery

Neurologic recovery is the main determinant for functional outcome and quality of life after post cardiac arrest.

Pre-Arrest function

Mild disability/“Normal”

Mod disability

Severe disability

Minimally Conscious State

Vegetative state

Coma

Brain death

Level of consciousness: Wakefulness

Subcortical (Less Vulnerable)

Content of consciousness: awareness

Cortical Structures (vulnerability)

Modified from Schiff 2006;23:1436-49
**Short Term Outcome: Clinical Exam and Test**

**Brain: Still in a Black Box**

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<th>Neurological examination</th>
<th>Biomarkers</th>
<th>Imaging</th>
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<tr>
<td>Spontaneous breathing activity</td>
<td>Serum (NSE, S100B)</td>
<td>CT</td>
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<tr>
<td>Pupillary light response</td>
<td>Cerebrospinal fluid (CK isoenzymes)</td>
<td>MRI</td>
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<td>Other brainstem reflexes</td>
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<td>PET</td>
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<td>Motor response (from GCS)</td>
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<td>Verbal response (from GCS)</td>
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<td>Comprehensive neurological</td>
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<tr>
<td>examination</td>
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</table>

No validated accurate real-time indicator (e.g. biomarker) of brain injury
- Impact on patient selection; injury stratification; Matching to therapy to injury
- Presently: Initial cardiac rhythm; Place of Arrest → Not reliable predictors of neuro outcome

No validate indicator of brain’s response to neuroprotective therapies (i.e. hypothermia).
- Impact on precise dose and duration and SAFETY of intervention.

Becker et al Circulation 2011
Short Term Outcome: Clinical Course & Interventions

Complications

- Recurrent cardiac arrest
- Cardiogenic shock
- Seizures

Neurologic/Behavioral Complications

- Brain Edema
- Seizures
- Myoclonus
- Autonomic Storms
- Movement Disorders
- Neuropsychiatric Disorders
- Cognitive Dysfunction

Lack of high quality clinical studies on acute brain injury interventions for these conditions

Becker, et al 2011

Khot, et al 2006

Xiong et al 2011
Impact of Prognostication on Outcomes

Death by WLST

Prognosticating Poor Outcome: Applicable in Era w/ No effective TX

Goal: WLST FPR<1%

Poor survival after cardiac arrest resuscitation: a self-fulfilling prophecy or biologic destiny?
Geocadin, Peberdy, Lazar CCMed 2012

- Need to develop newer tests/algorithms
- Need to refocus on favorable outcome to prevent premature WLST

Hypothermia:
Changes in FPRs 2-20%
Adaptation of the World Health Organization’s (WHO) International Classification of Functioning Disability and Health (*ICF; WHO, 2001,*).
Global Summative and Non Summative Measures

• Cerebral Performance Categories: 1-5
  – Mix deficit/Global ADL Measure
• Modified Rankin 0-6
  – Ordinal scale of functional status
• Glasgow Coma Scale: 3-15
  – Eye, Motor Verbal response (3-15 score)
• Glasgow Outcome Scale: 1-5
  – Consciousness, Recovery, Disability
• Glasgow Outcome Scale –Extended

Becker, et al Circ 2011
Neuropsychiatric Test in survivors of cardiac arrest show impairment in:

- Memory
- Executive Function
- Attention

Becker, et al 2011

Cognitive measures

- MMSE
- Memory (RAVLT)
- Executive functioning (Trail Making Test, parts A and B)
- Attention (DSST)

Depression measures

- Center for Epidemiologic Studies Depression Scale
- Hamilton Rating Scale for Depression
- Zung Self-Rating Depression Scale

Becker, et al 2011
Blueprint for Neuroscience Research developed the NIH Toolbox to fulfill a critical need for standardized instruments to assess neurologic and behavioral function.

- Normed for 3 to 85 y/o
- English and Spanish
- cost<2K equipment
- Public domain
- 2 hours (all test)

http://www.nihtoolbox.org
Present application: Parkinson disease, stroke, spinal cord injury, and traumatic brain injury
Next: Cardiac Arrest Survivors?

http://www.nihtoolbox.org
Quality of Life Measures

- Health Related Quality of Life:
  - Measures Perceived health status, functional status, social interactions, symptoms, cost, and burden

- AHA consensus suggestions:
  - Health Utilities Mark 3
  - Nottingham Health Profile


Becker, et al 2011
Safety and Quality Care: Outcome Measure and Public Concern

At least 44,000 to 98,000 people die from preventable deaths/year in US

Many opportunities to improve:

Focus on End of Life:
What is the goal of Prognostication Post-TH?

Meta-analysis shows poor quality studies:
- Unblinded; Uncontrolled studies
- Self-fulfilling Prophecies

Sandroni, et al Resus 2013

Meta-analysis: Improved Prognostic tests if done >72 hours; warned of inherent risk of becoming self-fulfilling.


Prognostication Following Cardiac Arrest:
Do We Have Our Patients’ Safety in Mind?

Murthy/Geocadin, CCMed 2014 in press

How many patients who would otherwise do well are prematurely subjected to WLST and death?

Types of Errors

Diagnosis
Error or delay in diagnosis
Failure to employ indicated tests
Use of outdated tests or therapy
Failure to act on results of monitoring or testing

Treatment
Error in the performance of an operation, procedure, or test
Error in administering the treatment
Error in the dose or method of using a drug
Avoidable delay in treatment or in responding to an abnormal test
Inappropriate (not indicated) care

Preventive
Failure to provide prophylactic treatment
Inadequate monitoring or follow-up of treatment

Other
Failure of communication
Equipment failure
Other system failure

Thank You
Questions?
Email:
rgeocad1@jhmi.edu

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