Creating a High-Performance Resuscitation System

Joseph P. Ornato, MD, FACP, FACC, FACEP

Professor & Chairman, Dept. of Emergency Medicine
Professor, Internal Medicine (Cardiology)
Virginia Commonwealth University Health System
Operational Medical Director
Richmond Ambulance Authority
Henrico County Division of Fire
Richmond, VA

Disclosure Information

Joseph P. Ornato, MD, FACP, FACC, FACEP
- Creating a High-Performance Resuscitation System

FINANCIAL DISCLOSURE:
- Cardiac Co-Chair & Consultant: NIH Resuscitation Outcomes Consortium (ROC)
- American Editor, Resuscitation
- Advisory Board, Key Technologies, Inc. (Transnasal Cooling Device)

UNLABELED/UNAPPROVED USES DISCLOSURE:
- Wriskwatch™, Emergency Medical Technologies

How are we going to reduce the mortality from OOH-CA meaningfully?

- Accurate data
- Prevention
- Implementing effective community systems of care
- Changing research funding priorities
- Breakthrough approaches
  - Detecting unwitnessed OOH cardiac arrest
  - Effective therapy for pulseless electrical activity (PEA)
  - Adapting principles & practices from high performance industries

Accurate Data

Cardiac arrest data

- No national U.S. registry
- Data sources
  - NIH Resuscitation Outcomes Consortium (ROC)
  - 8 U.S., 3 Canadian sites
  - Research sites
  - Epistry
  - CDC Cardiac Arrest Registry to Enhance Survival (CARES)
  - 46 communities in 31 states & DC
  - Voluntary sites

Public Health Burden of Cardiac Arrest

Heart Disease and Stroke Statistics
Go et al. Circulation 2013;127:e6-e245

10 x more deaths/year from OOH-CA than MI
Prevention

Challenges in SCD Prevention
Myerburg et al. JACC 2009; 54:747-63

Individual Patient’s SCD Risk

- Anomaly risk markers, post-MI
- Cardiac arrest survivor
- EF<30%, HF
- Prior coronary event
- High risk for CAD; no clinical events
- General population

Total # of SCD cases/year in USA

Implementing Community Systems of Care

Community Systems of Care

Regional variation in OOH-CA survival
Nichol et al. JAMA 2008; 300:1423-31

Resuscitation Outcomes Consortium (ROC)

- Albany: 1.1%
- cellular: 2.4%
- New York: 6.1%
- Rochester: 3.3%
- Pitts: 3.3%
- Portland: 6.5%
- Seattle: 8.1%
- Toronto: 3.2%
- Vancouver: 6.7%
Survival over Time: All Sites (Unadjusted)

AHA Mission Lifeline
History

- Regional Systems of Care for Out-of-Hospital Cardiac Arrest: A Policy Statement from the American Heart Association
- Task Force convened to explore addition of Cardiac Resuscitation quality improvement efforts to current M:LI Program
- Overlapping clinical conditions
- Common providers and procedures
- Well-documented effectiveness of regionalized STEMI systems
- Development of ideal systems for Cardiac Arrest

AHA Mission Lifeline
Ideal System

- Patient centered care
- High quality care that is safe, effective, and timely
- Stakeholder consensus on systems infrastructure
- Increased operational efficiencies
- Measurable patient outcomes
- Evaluation mechanism to ensure that quality of care measures reflect changes in evidence-based research
- A role for local community hospitals so as to avoid a negative impact that could eliminate critical access to local healthcare
- Reduction in disparities of healthcare delivery

Guiding Principles for Regionalization of Post-Arrest Care

- 2-3 min fire AED first response
- 6 min all-ALS system
- 12-lead ECGs, capnography, pulse oximetry, AutoPulse™, wireless internet, GPS automated vehicle locators on all units

Resuscitation strategy approach

- Optimize blood flow/oxygen delivery
  - Vasopressin 40 mcg IV alternating with epinephrine 1 mg IV every 5 min
  - Autopulse™ CPR (2 min) before DF with continuous chest compression
    - No interruptions of CPR for defibrillation
- Shorten the time to airway & drug therapy
  - King LTS™
  - EZ-IO™
- Protect the brain & heart
  - Pre-hospital therapeutic hypothermia during & post-arrest
Advanced Resuscitation Cooling Therapeutics Intensive Care

- ARCTIC Alert from field
- VCU never on diversion for ARCTIC pts.
- ARCTIC Team
  - ED physician and nurse
  - ARCTIC attending (only 5)
  - CCU/Interventional fellow
  - RN Coordinator
- Inclusion criteria for ARCTIC
  - Comatose or unable to follow verbal commands
  - Initial rhythm VF
  - Initial rhythm witnessed PEA or ASYS
- Exclusion criteria
  - DNAR, terminal illness
  - Shock unresponsive to vasopressors
  - Uncontrolled bleeding

EM focuses on stabilizing patient
- Initiates early goal directed therapy
- CECU/ICU team places cooling catheter and continues standardized post-arrest care

"Induction Center Concept"

VCU ARCTIC Patients/Year

Detailed neuro-cognitive testing & brain injury rehabilitation program

- Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)
  - Immediate memory
  - List learning
  - Story memory
  - Visuospatial/constructual orientation
  - Complex figure copy / trial making
  - Line orientation
  - Language
  - Picture naming
  - Semantic fluency
  - Attention
    - Digit span
    - Coding
  - Delayed memory
    - Recall of above
  - Back Depression Scale
  - Brain injury rehabilitation
  - 3 and 6 month neuro-cognitive testing

Neuro-cognitive issues

- CPC is not accurate in assessing true neurocognitive function
- Short term memory deficit
  - Profound
  - Transient
- Variable resolution
  - "Reverse PTSD"
  - "Flock back behavior"
- Question ability to return to work
- Family stress and re-integration

Changing Research Funding Priorities

Reasons for the paucity of SCD funding and research

- Misperception that SCD is largely an untreatable problem
- Most of the existing therapies are generic, patent unprotected drugs or devices
- Few novel, patented-protected pharmaceuticals are in the pipeline
- Funding circle paradox

You created this PDF from an application that is not licensed to print to novaPDF printer (http://www.novapdf.com)
Need for Cardiac Arrest Research

ROC focus areas

- **Primary**
  - Pre-hospital, randomized clinical trials that test very early (i.e., field or ED) administration of promising drugs, devices, and strategies with a goal of improving outcomes in victims of cardiac arrest or severe traumatic injury

- **Secondary**
  - Smaller pilot, feasibility or surrogate endpoint studies
  - Epidemiological Registry - EPISTRY
  - 8 cases in Epistry
  - 179,310 cardiac arrests; 21,656 traumas
  - Unique CPR digital process data capture requested by PRC and DSMB

ROC accomplishments (2003-14)

- **Publications**
  - 54 abstracts at national meetings
  - AHA, Resus, NAEMSP, SAEM
  - 58 peer-reviewed publications

<table>
<thead>
<tr>
<th>Journal</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>AJRCCM</td>
<td>31.3</td>
</tr>
<tr>
<td>Ann</td>
<td>30.0</td>
</tr>
<tr>
<td>Circulation</td>
<td>16.7</td>
</tr>
<tr>
<td>JACEP</td>
<td>14.0</td>
</tr>
<tr>
<td>Med J</td>
<td>14.5</td>
</tr>
<tr>
<td>N Engl J Med</td>
<td>7.3</td>
</tr>
<tr>
<td>Resuscitation</td>
<td>6.2</td>
</tr>
<tr>
<td>JAMA</td>
<td>4.5</td>
</tr>
<tr>
<td>Ann Emerg Med</td>
<td>4.1</td>
</tr>
<tr>
<td>Am J Public Health</td>
<td>3.6</td>
</tr>
<tr>
<td>Resuscitation</td>
<td>2.6</td>
</tr>
<tr>
<td>Trainers</td>
<td>2.5</td>
</tr>
</tbody>
</table>

- **Change in medical practice**
  - AHA/ILCOR Resuscitation Guidelines (GL)
  - 15 GL worksheets
  - 31 chapters in CPR GLs
  - 7 additional publications
  - 41 consensus panel statements
  - ROC is the key data source for OHCA

- **New hypotheses & funding**
  - 490 additional resuscitation & trauma publications by ROC PI's and its leadership (2003-12)
  - Additional grants: 10 NIH, 9 DOD, 1 CDC, 31 other

NIH Resuscitation Outcomes Consortium (ROC) 2005-15

- First large-scale, governmentally-sponsored North American effort to conduct definitive pre-hospital, randomized clinical trials in out-of-hospital cardiac arrest (OHCA) and severe traumatic injury

- Focus is on very early delivery of interventions by EMS providers, when there is optimal potential for benefit

ROC clinical trials (2003-14)

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Design</th>
<th>N</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac Arrest Epiphany</td>
<td>Cardiac</td>
<td>Observational</td>
<td>179,310</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Trial in Hype/Proprietary</td>
<td>Trauma</td>
<td>RCT</td>
<td>17,894</td>
<td>Completed</td>
</tr>
<tr>
<td>PRIMED 11G1</td>
<td>Cardiac</td>
<td>RCT</td>
<td>11,892</td>
<td>Completed</td>
</tr>
<tr>
<td>PRIMED 11G2</td>
<td>Cardiac</td>
<td>RCT</td>
<td>13,126</td>
<td>Completed</td>
</tr>
<tr>
<td>CPR feedback</td>
<td>Cardiac</td>
<td>Ancillary RCT</td>
<td>1,586</td>
<td>Completed</td>
</tr>
<tr>
<td>Hypertonic Shock</td>
<td>Trauma</td>
<td>RCT</td>
<td>30</td>
<td>Completed</td>
</tr>
<tr>
<td>Hypertonic TBI</td>
<td>Trauma</td>
<td>RCT</td>
<td>122</td>
<td>Completed</td>
</tr>
<tr>
<td>Cardiac RESCUE TBI</td>
<td>Trauma</td>
<td>RCT &amp; Pilot</td>
<td>30</td>
<td>Completed</td>
</tr>
<tr>
<td>Cardiac RESCUE Shock</td>
<td>Trauma</td>
<td>RCT &amp; Pilot</td>
<td>30</td>
<td>Completed</td>
</tr>
<tr>
<td>Blast ground cohort</td>
<td>Trauma</td>
<td>Case series</td>
<td>30</td>
<td>Completed</td>
</tr>
<tr>
<td>Blast Resus – shock</td>
<td>Trauma</td>
<td>RCT &amp; Pilot</td>
<td>30</td>
<td>Completed</td>
</tr>
<tr>
<td>Blast vs 10-2 in OHCA</td>
<td>Cardiac</td>
<td>RCT</td>
<td>23,600</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Blast vs 10-2 cohort</td>
<td>Trauma</td>
<td>Case series</td>
<td>218</td>
<td>Completed</td>
</tr>
<tr>
<td>PROPPR massive transfusions</td>
<td>Trauma</td>
<td>RCT</td>
<td>680</td>
<td>Completed</td>
</tr>
</tbody>
</table>

Total: 287,957

ROC training a new generation of resuscitation/trauma researchers

- 5 funded core training sites provides salary for core leader (Toronto, Ottawa, Oregon, Alabama, Pittsburgh)
- Leveraging site support - trainee funding comes from the site’s institution
- Trainees attend ROC meetings & learn from multiple site mentors
- Trainees conduct research on local or ROC-wide databases
- Data sharing – ROC provides an 18 month Epistry data set that can be used for local analysis

**Examples**

- University of Toronto
  - 18 graduate students/4 masters graduated to date; 4 NIH fellows; 1 paramedic associate scientist; 2 post-docs; 10 young investigators (EM, Critical Care, Trauma, Surgery)
  - 20 have conducted research with local or ROC-wide data
  - 14 publications, 8 new grants
- Oregon Health & Sciences University
  - 13 fellows trained (3 current)
  - 33 abstracts, 32 manuscripts, 8 new grants
- Pittsburgh
  - 15 fellows, 7 have completed Master’s; 2 new research directors elsewhere
  - 81 publications
Breakthrough Approaches: Unwitnessed Cardiac Arrest

Detection of the unwitnessed OOH-CA

- Wriskwatch™
- Emergency Medical Technologies, N Miami Beach, Florida
- http://www.emergencymedtech.com

Difference between conventional 911 response and Wriskwatch™ detected unwitnessed cardiac arrest

Pulseless electrical activity

8 domestic Yorkshire swine
PEA induced by ventilation with a hypoxic mixture
Autopulse™ synchronized compressions applied
Breakthrough Approaches:
Adapting Principles & Practices from High Performance Industries

Aviation vs. resuscitation

<table>
<thead>
<tr>
<th>Phases of Flight</th>
<th>Phases of Resuscitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preflight checks</td>
<td>Code cart/equipment checks</td>
</tr>
<tr>
<td>Preflight crew brief</td>
<td>Delegation of tasks</td>
</tr>
<tr>
<td>Take-off/climb</td>
<td>Initiate CPR/DF/airway/IV</td>
</tr>
<tr>
<td>Cruise</td>
<td>Continue CPR/DF/IV</td>
</tr>
<tr>
<td>Descent/landing</td>
<td>ROSC or cease resuscitation</td>
</tr>
<tr>
<td>Post-flight checks</td>
<td>Stabilization, post-resusc care</td>
</tr>
<tr>
<td>Crew debriefing</td>
<td>Team debriefing</td>
</tr>
</tbody>
</table>

Aviation & resuscitation are team efforts

What’s different about aviation?

- Pilots understand that flying is a privilege
- Aviation functions in a rigorous culture of safety
- Skills & procedures are standardized
- Teamwork is the daily routine
- Pilots anticipate, train, plan & brief for emergencies
- Pilots lives are on the line every flight

Aviation toolbox

- Communication
  - Sterile cockpit rule
- Procedures
  - Crosschecks
  - Mandatory readbacks
  - Mandatory checklist use
  - Instrument guided flight

Aviation toolbox

- Communication
  - Sterile cockpit rule
- Procedures
  - Crosschecks
  - Mandatory readbacks
  - Mandatory checklist use
  - Instrument guided flight
Summary

- Accurate data
- Prevention
- Implementing effective community systems of care
- Changing research funding priorities
- Breakthrough approaches
  - Detecting unwitnessed OOH cardiac arrest
  - Effective therapy for pulseless electrical activity (PEA)
  - Adapting principles & practices from high performance industries