Update on Sudden Cardiac Death and Resuscitation

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Background

• Cardiac arrest is a significant public health issue with ~326,000 people affected by per year in the US.
• This is 37 people per hour having a cardiac arrest event
• Neurologically intact survival from these events is generally poor and varies based on where someone has an arrest.

Basic concepts we know?

• Early response saves lives
• Early CPR saves lives
• More people performing CPR saves lives
• Good CPR saves lives

Tough decisions...

A irway
B reathing
C ompressions

Author: Rama  CC BY-SA 2.0 FR
Overarching Concept

GOAL
Improving outcomes from cardiac arrest

Lesson Learned
It takes a community to save a life.

Story of a Survivor

Links in the Chain

“Emergency systems that can effectively implement these links can achieve witnessed VF cardiac arrest survival greater than 50%”

Outline

• Review some current data on cardiac arrest survival
• Discuss the key aspects for improved outcomes in the cardiac arrest care
• Define the criteria needed for performance of high quality resuscitation
**Chance of Survival?**

- So how are we really doing…?

![Graph showing the chance of survival over minutes before CPR and AED use.](image)

**Current Statistics**

<table>
<thead>
<tr>
<th>Year</th>
<th>Incidence</th>
<th>Bystander CPR</th>
<th>Survivor Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>382,800</td>
<td>41.0%</td>
<td>11.4%</td>
</tr>
<tr>
<td>2013</td>
<td>359,400</td>
<td>40.1%</td>
<td>9.5%</td>
</tr>
</tbody>
</table>

American Heart Association, Heart Disease and Stroke Statistics – 2013 Update

**VF Cardiac Arrest Survival Seattle & King County, 2002-2013**

- 72% of witnessed arrests receive bystander CPR
- EMS personnel achieve median ≥ 80% CPR fraction

![Graph showing VF cardiac arrest survival in Seattle & King County, 2002-2013.](image)

Image used with permission from Public Health - King County, Washington


**Lessons Learned for Optimal Resuscitation**

- Good Resuscitations starts from Good BLS Care
  - Improve Bystander Response
  - With recognition comes ACTION
  - Improve the Performance of High Quality CPR
**Bystander Response**

- Need to recognize something is wrong
- Large part of action is dependent on psychosocial and behavioral elements of witnesses.
- This is different for every population.
- Want bystanders to perform CPR with a basic prompt:
  
  "People who suddenly collapse…"

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**CPR Type** | **OR Survival**
--- | ---
No bystander CPR | Reference
Dispatcher-assisted bystander CPR | 1.45 (95% CI, 1.21, 1.73)
Bystander CPR without dispatcher assistance | 1.69 (95% CI, 1.42, 2.01)

**Dispatch Assisted CPR**

<table>
<thead>
<tr>
<th>CPR Type</th>
<th>OR Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>No bystander CPR</td>
<td>Reference</td>
</tr>
<tr>
<td>Dispatcher-assisted bystander CPR</td>
<td>1.45 (95% CI, 1.21, 1.73)</td>
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<td>1.69 (95% CI, 1.42, 2.01)</td>
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</table>

*Rea Circulation. 2001; 104: 2513-2516*
2015 BLS Algorithm

Verify scene safety

Victim is unresponsive
Shout for nearby help.
Activate emergency response system via mobile device (if appropriate),
Get AED and emergency equipment (or send someone to do so)

Normal breathing, has pulse

Look for no breathing or only gasping and check pulse (simultaneously).
Is pulse definitely felt within 10 seconds?

No normal breathing, has pulse

No breathing or only gasping, no pulse

Recognition of Abnormal Breathing

<table>
<thead>
<tr>
<th></th>
<th>Gasping</th>
<th>Survival % (n)</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All cardiac arrest (n=1218)</td>
<td>No (1027)</td>
<td>7.8% (80)</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Yes (191)</td>
<td>28.3% (54)</td>
<td>3.4 (2.2–5.2)†</td>
</tr>
</tbody>
</table>


Gasping and BCPR

<table>
<thead>
<tr>
<th>Bystander CPR?</th>
<th>Gasping</th>
<th>Survival % (n)</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes (481)</td>
<td>No (404)</td>
<td>9.4% (38)</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Yes (77)</td>
<td>39.0% (30)</td>
<td>5.1 (2.7–9.4)†</td>
</tr>
<tr>
<td>No (737)</td>
<td>No (623)</td>
<td>6.7% (42)</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Yes (114)</td>
<td>21.1% (24)</td>
<td>2.4 (1.2–4.3)†</td>
</tr>
</tbody>
</table>

Improving CPR Performance

- Teach Good Basic Life Support:
- Focusing on High Quality Aspects:
  - Chest compression Rate
  - Chest compression Depth
  - Compression Fraction
- Train to the goals:
  - Rate: 100-120 bpm
  - Depth: 2.0 - 2.4 inches

CPR Quality

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression Fraction</td>
<td>92%</td>
</tr>
<tr>
<td>Mean Compression Rate</td>
<td>102</td>
</tr>
<tr>
<td>Mean Compression Depth</td>
<td>49</td>
</tr>
<tr>
<td>Compression without Leaning</td>
<td>75%</td>
</tr>
<tr>
<td>Mean Ventilation Rate</td>
<td>9</td>
</tr>
</tbody>
</table>

Chest Compression Rate

Recommendation:
- Compression rate: 100-120/minute

Why?
- Often actual rate of compressions provided are below 100 bpm.
- Data demonstrates that compressions below 100, and above 120, adversely affect outcomes

Resuscitation Science

Relationship Between Chest Compression Rates and Outcomes From Cardiac Arrest

Ahmed H. Idris, MD; Danielle Gailey, BS; Terri P. Arifovski, MD; Stefanie Brown, PhD; Laurie J. Morin, MD, MSc; Patrick Nichols, DO; Judy Powell, BSN; Mohammed Elsay, MD; Blake L. Ray, MS; Suzanne L. Atkins, MD; Robert Berg, MD; Dias Davis, MD; Ian Wells, MD, MSc; George Sopko, MD, MPH; Graham Nichol, MD, MPH; the Resuscitation Outcomes Consortium (ROC) Investigators

Circulation 2012; 125: 3004-3012

Conclusion:
- 3098 patients with OHCA
- Examined association of chest compression rate with outcomes of ROSC and survival
- ROSC rates peaked at compression rates ~125 bpm and then declined.
What about depth?

- Push Hard and Fast (> 2.0 inches, 5 cm)
- Has transitioned in this Guideline to 2.0 to 2.4 inches (5-6 cm)
- Why?
  - Depth is important for optimal survival
  - Increased danger with Compressions > 2.4 in

Conclusion:

- A number of iatrogenic injuries in male patients was associated with compressions during CPR increased as depth was > 6 cm.
- These were not fatal.

Conclusions:

- “Deeper compressions were associated with increased survival and functional outcomes following OHCA…” (aOR: 1.29)
High Quality CPR is Critical

Without effective chest compressions:
• Oxygen flow to brain stops
• Oxygen flow to heart stops
• Drugs go nowhere

Update on Sudden Cardiac Death and Resuscitation

Ruchika Husa, MD
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ROSC in Comatose Survivors

• Induced Hypothermia
• Early Invasive Strategy
• Best ICU care

Why should we cool?

• Reperfusion injury
  • Necrosis/apoptosis
  • Inflammation
  • Reactive oxygen species
• Improved defibrillation
• Neurologic recovery
Why should we cool?

The New England Journal of Medicine

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MILD THERAPEUTIC HYPOTHERMIA TO IMPROVE THE NEUROLOGIC OUTCOME AFTER CARDIAC ARREST

Entry criteria: witnessed cardiac arrest with first resuscitation attempt 5-15 min after collapse, ROSC (<60 from collapse), persistent coma, VF.

Exclusion criteria: severe cardiogenic shock, hypotension (SBP <90mmHg), persistent arrhythmias, primary coagulopathy.

Approximately 92% of screened participants were excluded.

PROTOCOL

- In European study, patients were cooled using a special mattress and ice packs. Target temp 32°C to 34°C for 24 hours. Rewarming over 8 hours.
- Australian study used cold packs in the field. Target temp 33°C for 12 hours. Rewarming over 6 hours.

Why should we cool?

- Entry criteria: witnessed cardiac arrest with first resuscitation attempt 5-15 min after collapse, ROSC (<60 from collapse), persistent coma, VF.
- Exclusion criteria: severe cardiogenic shock, hypotension (SBP <90mmHg), persistent arrhythmias, primary coagulopathy.
- Approximately 92% of screened participants were excluded.
### NEUROLOGIC OUTCOME AND MORTALITY AT SIX MONTHS

<table>
<thead>
<tr>
<th>OUTCOME</th>
<th>NORMOTHERMIA no./total no. (%)</th>
<th>HYPOTHERMIA no./total no. (%)</th>
<th>RISK RATIO (95% CI)*</th>
<th>P VALUE†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Favorable neurologic outcome</td>
<td>54/137 (39)</td>
<td>75/136 (55)</td>
<td>1.40 (1.08–1.81)</td>
<td>0.009</td>
</tr>
<tr>
<td>Death</td>
<td>65/138 (55)</td>
<td>56/137 (41)</td>
<td>0.74 (0.58–0.95)</td>
<td>0.02</td>
</tr>
</tbody>
</table>

**ALS Task Force recommendation in 2002**

- Unconscious adult patients with spontaneous circulation after out-of-hospital cardiac arrest should be cooled to 32°C to 34°C for 12-24 hours when initial rhythm was ventricular fibrillation.
- Such cooling may be beneficial for other rhythms or in-hospital cardiac arrest.

**Recent trial**

- Randomized 950 unconscious adults after out-of-hospital cardiac arrest of presumed cardiac cause (irrespective of initial rhythm) to targeted temperature management at either 33°C or 36°C.
- The primary outcome was all-cause mortality through the end of the trial.
- Secondary outcomes included a composite of poor neurologic function or death at 180 days.

**Trial design**

- Randomized 950 unconscious adults after out-of-hospital cardiac arrest of presumed cardiac cause (irrespective of initial rhythm) to targeted temperature management at either 33°C or 36°C.
- The primary outcome was all-cause mortality through the end of the trial.
- Secondary outcomes included a composite of poor neurologic function or death at 180 days.
**Results**

Table 2. Outcomes.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>36°C Group</th>
<th>33°C Group</th>
<th>Hazard Ratio or Risk Ratio (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary outcome: deaths at end of trial</td>
<td>215/473 (50)</td>
<td>225/466 (48)</td>
<td>1.06 (0.89–1.28)</td>
<td>0.51</td>
</tr>
<tr>
<td>Secondary outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neurologic function at follow-up</td>
<td>251 (54)</td>
<td>242 (52)</td>
<td>1.02 (0.88–1.16)</td>
<td>0.78</td>
</tr>
<tr>
<td>Modified Rankin scale score of 4–6</td>
<td>145 (32)</td>
<td>239 (52)</td>
<td>1.01 (0.89–1.14)</td>
<td>0.87</td>
</tr>
<tr>
<td>Deaths at 180-days</td>
<td>226 (48)</td>
<td>220 (47)</td>
<td>1.01 (0.87–1.15)</td>
<td>0.92</td>
</tr>
</tbody>
</table>

**Why should we cool?**
### When? Pre-hospital hypothermia

- Kim et al, Effect of pre-hospital induction of mild hypothermia on survival and neurological status among adults with cardiac arrest: a randomized clinical trial.
- Use of pre-hospital cooling reduced core temperature by hospital arrival and reduced the time to reach a temperature of 34° C.
- It did not improve survival or neurological status among patients resuscitated from pre-hospital VF or those without VF.

### Timing of Induced Hypothermia

- As soon as possible after presentation to the ER.
- One nonrandomized report found an associated 20% increase in mortality rate with every hour of delay in initiating cooling.
- It should neither delay nor interfere with an early invasive approach.

### Who should we cool?

- All arrest victims?
  - Brain doesn't know the rhythm
- Only ventricular fibrillation?
  - Evidence-based approach
- Non-VF patients?
  - Infection
  - CHF
  - Bleeding

### Resuscitation - September 2011

Mild therapeutic hypothermia is associated with favourable outcome in patients after cardiac arrest with non-shockable rhythms:
- Retrospective analysis of adult cardiac arrest survivors suffering a witnessed out-of-hospital cardiac arrest with asystole or pulseless electric activity as the first documented rhythm.
- Patients who were treated with mild therapeutic hypothermia were more likely to have good neurological outcomes, odds ratio of 1.84 (95% confidence interval: 1.08–3.13).
- Mortality was significantly lower in the hypothermia group (odds ratio: 0.56; 95% confidence interval: 0.34–0.93).
Does therapeutic hypothermia benefit adult cardiac arrest patients presenting with non-shockable initial rhythms?: A systematic review and meta-analysis of randomized and non-randomized studies.

- TH is associated with reduced in-hospital mortality for adults patients resuscitated from non-shockable CA.

How should we cool?

- Surface cooling
  - Evaporative
  - Ice packs/chemical
  - Cooling pads
- Internal strategies
  - Cooled intravenous fluids
  - Intravascular catheters
  - Intranasal catheters
Complications of Hypothermia

- Coagulopathy
  - Overshoot?
- Hemodynamic
- Dysrhythmias
- Infectious
  - Sepsis, pneumonia
- Electrolyte disturbances

Complications

Summary for TTM: 2015 update

- All comatose adult patients with ROSC after cardiac arrest should undergo TTM.
- Mild hypothermia equally good. Temperature range 32-36 degrees Celsius.
- Routine pre-hospital hypothermia is not recommended.
- Although some methods of cooling are more convenient, none have been shown superior to the others for patient outcomes.

Coronary Angiography

- Background The 2013 STEMI guidelines recommend performing immediate angiography in resuscitated patients whose initial electrocardiogram shows STEMI. The optimal approach for those without STEMI post-cardiac arrest is less clear.
- Kern et al A retrospective evaluation of a post–cardiac arrest registry was performed.
- Objectives The aim of this study was to compare outcomes and coronary angiographic findings in post–cardiac arrest patients with and without ST-segment elevation myocardial infarction (STEMI).

<table>
<thead>
<tr>
<th>Complication</th>
<th>Normothermia</th>
<th>Hypothermia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bleeding of any severity</td>
<td>5(10)</td>
<td>1(2)</td>
</tr>
<tr>
<td>Need for platelet transfusion</td>
<td>67/167 (39)</td>
<td>68/141 (44)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>10/137 (7)</td>
<td>17/135 (13)</td>
</tr>
<tr>
<td>Sepsis</td>
<td>5/138 (7)</td>
<td>7/135 (11)</td>
</tr>
<tr>
<td>Pancreatitis</td>
<td>7/138 (5)</td>
<td>4/135 (3)</td>
</tr>
<tr>
<td>Renal failure</td>
<td>14/138 (10)</td>
<td>13/135 (9)</td>
</tr>
<tr>
<td>Hemodialysis</td>
<td>6/138 (4)</td>
<td>6/135 (4)</td>
</tr>
<tr>
<td>Pulmonary edema</td>
<td>5/138 (4)</td>
<td>9/135 (7)</td>
</tr>
<tr>
<td>Seizures</td>
<td>11/138 (8)</td>
<td>10/135 (7)</td>
</tr>
<tr>
<td>Lethal or long-lasting asystole</td>
<td>44/138 (32)</td>
<td>49/135 (36)</td>
</tr>
<tr>
<td>Presence core</td>
<td>0/138</td>
<td>0/135</td>
</tr>
</tbody>
</table>
The database consisted of 746 comatose post–cardiac arrest patients including 198 with STEMI (26.5%) and 548 without STEMI (73.5%).

- A culprit vessel was more frequently identified in those with STEMI, but also in one-third of patients without STEMI (80.2% vs. 33.2%; p = 0.001).
- The majority of culprit vessels were occluded (STEMI, 92.7%; no STEMI, 69.2%; p < 0.0001).
- An occluded culprit vessel was found in 74.3% of STEMI patients and in 22.9% of no STEMI patients.

Coronary Angiography

Figure 2. Survival to Discharge and Favorable Neurological Outcome in Those Without ST Elevation Coronary angiography is associated with improved survival to hospital discharge among patients without ST-segment elevation myocardial infarction (A) and with good neurologic outcomes.
Out-of-hospital cardiac arrest (OHCA) patients who have achieved return of spontaneous circulation (ROSC), but remain comatose

<table>
<thead>
<tr>
<th>Within 10 minutes of hospital arrival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perform 12-lead electrocardiography (ECG) to identify patients who benefit from emergent angiography</td>
</tr>
<tr>
<td>Induce targeted temperature management (TTM) with mild therapeutic hypothermia (TH) to limit tissue injury following cardiac arrest</td>
</tr>
</tbody>
</table>

**ST-segment elevation on the ECG**

- ST-segment elevation myocardial infarction (STEMI) team
- Consider survival benefit/risk ratio, especially if multiple unfavorable resuscitation features are present

**Indications for emergent angiography**

- ST-segment elevation on the ECG
- No ST-segment elevation on the ECG

- Act for post-resuscitation features
- Consult with interventional cardiology & intensive care services
- Transport to cardiac catheterization laboratory (CCL) once a decision is made to proceed with coronary angiography

**Patients deemed suitable for emergency coronary angiography**

- Define coronary anatomy
- Identify coronary lesion
- Percutaneous coronary intervention (PCI)
- Function and hemodynamic assessment
- Provide mechanical LV support if needed

**Patients with multiple unfavorable resuscitation features**

- Unwitnessed arrest
- pH < 7.2
- Initial rhythm: Non-VF
- Lactate > 7
- No bystander CPR
- > 30 min to ROSC
- Age > 85
- End stage renal disease
- Ongoing CPR
- Noncardiac causes (e.g., traumatic arrest)

**Patients are less likely to benefit from coronary intervention**

- Individualized patient care and interventional cardiology consultation are strongly recommended

**Coronary Angiography in Comatose patients with ROSC**

- Conclusions: Early coronary angiography is associated with improved functional outcome among resuscitated patients with and without STEMI. Resuscitated patients with a presumed cardiac etiology appear to benefit from immediate coronary angiography.

- PEARL Study.
Post-Arrest Care

- Cooling
- Emergency PCI
- Good ICU care
- Rehabilitation

Sunde (2007) Resuscitation