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...

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.

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**Story of a Survivor**

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**Links in the Chain**

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

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**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…?

**Survival (%)**

<table>
<thead>
<tr>
<th>Minutes before CPR and AED Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
</tr>
</tbody>
</table>

**Current Statistics**

<table>
<thead>
<tr>
<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>
</tr>
<tr>
<td>2013</td>
<td>359,400</td>
<td>40.1%</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% CCFraction

**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…”

<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>
</tr>
<tr>
<td>Bystander CPR without dispatcher assistance</td>
<td>1.69 (95% CI, 1.42, 2.01)</td>
</tr>
</tbody>
</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 %</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(n)</td>
<td></td>
</tr>
<tr>
<td>All cardiac arrest (n=1218)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (1027)</td>
<td></td>
<td>7.8% (80)</td>
<td>1.00</td>
</tr>
<tr>
<td>Yes (191)</td>
<td></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>


High Quality CPR

# 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 effect outcomes

## Resuscitation Science

**Relationship Between Chest Compression Rates and Outcomes From Cardiac Arrest**

Ahamed H, Odin, MD; Danielle Gallow, BS; Tom P. Ashfard, MD; Stefan Brown, PhD; Laurie F. Merzoue, MD, MSc; Patrick Nichols, DO; Andy Powell, BSN; Mohammad Anta, MD; Brian L. Boga, MSc; Brian L. Adams, MD; Robert Berg, MD; Dan Davis, MD; Ian city, MD, MSc; George Sopas, MD, MPh; Graham Nollet, MD, MPh.

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.
Competition Rate and Depth Relationship

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

**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

Training lay persons to do CPR

Mouth-to-mouth resuscitation?

Update on Sudden Cardiac Death and Resuscitation

Ruchika Husa, MD
Assistant Professor – Clinical Department of Cardiovascular Medicine
The Ohio State University Wexner Medical Center
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?

- 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?**

![Graph showing survival rates for hypothermia and normothermia over time.](Hypothermia After Cardiac Arrest Study Group (2002) NEJM)

**NEUROLOGIC OUTCOME AND MORTALITY AT SIX MONTHS**

<table>
<thead>
<tr>
<th>OUTCOME</th>
<th>NORMOTHERMIA</th>
<th>HYPOTHERMIA</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

**Targeted Temperature Management at 33°C versus 36°C after Cardiac Arrest**

Nielsen-House, M.D., Ph.D., Jørgen L. Hjortshøj, M.D., Ph.D., Tobias Gronhøj, M.D., Ph.D., David Efting, M.D., Ph.D., Jørgen Gislason, M.D., Ph.D., Fred Rasmussen, M.D., Ph.D., Iain Ades, M.D., Ph.D., Thibault F. Brugieres, M.D., Ph.D., Morten Krarup, M.D., Ph.D., Jørgen E. Pedersen, M.D., Ph.D., Tone H. Pedersen, M.D., Ph.D., Henrik T. Schou, M.D., Ph.D., Thomas G. Rasmussen, M.D., Ph.D., Flemming Christiansen, M.D., Ph.D., and Lars Borch-Johnsen, M.D., Ph.D.

- **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.

**Body Temperature During The Intervention Period**

- **33°C** group
- **36°C** group

**Probability Of Survival Through The End Of The Trial**

- **33°C** group
- **36°C** group
**Results**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>33°C Group</th>
<th>36°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>235/473 (50)</td>
<td>225/466 (48)</td>
<td>1.06 (0.89–1.26)</td>
<td>0.51</td>
</tr>
<tr>
<td>Secondary outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neurological function at follow-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPC of 3-5</td>
<td>251/469 (54)</td>
<td>243/464 (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>245/469 (52)</td>
<td>239/464 (52)</td>
<td>1.01 (0.89–1.14)</td>
<td>0.87</td>
</tr>
<tr>
<td>Deaths at 180 days</td>
<td>226/473 (48)</td>
<td>220/466 (47)</td>
<td>1.01 (0.87–1.15)</td>
<td>0.92</td>
</tr>
</tbody>
</table>

**Why should we cool?**

- 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.

**When? Pre-hospital 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).

**Resuscitation - February 2012**

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
Cooling Catheters

Surface Cooling

Complications of Hypothermia

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

Complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Normothermia</th>
<th>Hypothermia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bleeding of any severity†</td>
<td>50/128 (19)</td>
<td>28/133 (26)</td>
</tr>
<tr>
<td>Need for platelet transfusion</td>
<td>49/137 (29)</td>
<td>56/125 (37)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>2/138 (7)</td>
<td>17/135 (11)</td>
</tr>
<tr>
<td>Sepsis</td>
<td>2/138 (7)</td>
<td>17/135 (11)</td>
</tr>
<tr>
<td>Pancreatitis</td>
<td>14/138 (10)</td>
<td>13/135 (9)</td>
</tr>
<tr>
<td>Renal failure</td>
<td>6/138 (4)</td>
<td>6/135 (4)</td>
</tr>
<tr>
<td>Hemodialysis</td>
<td>5/138 (4)</td>
<td>9/136 (7)</td>
</tr>
<tr>
<td>Pulmonary edema</td>
<td>11/138 (8)</td>
<td>10/136 (7)</td>
</tr>
<tr>
<td>Seizures</td>
<td>6/138 (32)</td>
<td>49/125 (36)</td>
</tr>
<tr>
<td>Lethal or long-lasting asystole</td>
<td>0/138</td>
<td>0/136</td>
</tr>
</tbody>
</table>
**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).

### Coronary Angiography

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 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

Post-Arrest Care

The feasibility of a regional cardiac arrest receiving system

Daniel P. Davis, Roger Fisher, Steven Aguilar, Marcelyn Metz, Ginger Ochs, Lana McCallum-Brown, Prasanthi Ramanujam, Colleen Buono, Gary M. Vilkas, Theodore C. Chan, James V. Dunford

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