Cardiac arrest: more than just defibrillation?

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Speaker disclosures

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                 American Heart Association
                 Doris Duke Foundation

Speaking Honoraria:  Philips Medical Systems
                    Medivance Corporation

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Cardiac arrest: introduction
Cardiac arrest epidemiology in the US

400,000 arrests / year

2 / 3 Out-of-hospital

1 / 3 In-hospital

1-5% survival to hospital discharge

10-20% Seattle: 10-20%!
Mortality from cardiac arrest

Time

% Surviving

arrest
CPR
defibrillation
ROSC
hospital discharge
Symposium on Emergency Resuscitation

Rescue Breathing and Closed Chest Cardiac Massage

August 21-25 1961
Stavanger
Norway
Approaching 50 years of modern CPR

A. Peter Safar, 1950s
B. Early symposium on CPR
Cardiac arrest: fundamentals of therapy

“Chain of Survival”

Prompt Access  Early CPR  Early Defib  ACLS Care

ACLS Provider Manual
(American Heart Association)
Bystander contacted 9-1-1

standard CPR (n=279)  chest compression alone (n=241)

29/279 (10.4%)  35/241 (14.6%)

Improvement due to:
   ? less time to train
   ? better CPR strategy

p=0.18

Hallstrom et al, 2000
Chest compression alone CPR: revisited

CPR with Chest Compression Alone or with Rescue Breathing

Thomas D. Rea, M.D., Carol Fahrenbruch, M.S.P.H., Linda Culley, B.A., Rachael T. Donohoe, Ph.D., Cindy Hambly, E.M.T., Jennifer Innes, B.A., Megan Bloomingdale, E.M.T., Cleo Subido, Steven Romines, M.S.P.H., and Mickey S. Eisenberg, M.D., Ph.D.

2010

Bystander contacted 9-1-1

standard CPR (n=960)

11.5%

chest compression alone (n=981)

14.4% (OR 2.9)

Survival to DC
Chest compression alone CPR: revisited

Dispatcher-Assisted Cardiopulmonary Resuscitation
Risks for Patients Not in Cardiac Arrest

Lindsay White, MPH; Joseph Rogers, MS; Megan Bloomingdale; Carol Fahrenbruch, MSPH; Linda Culley, BA; Cleo Subido, RPL; Mickey Eisenberg, MD, PhD; Thomas Rea, MD, MPH

CPR has very little risk to patients:

247 patients given CPR erroneously

12% reported discomfort
2% had fracture - none with visceral organ damage
Standard CPR vs CC alone

Blood pressure vs Time

= chest compression

Berg et al, 2001
Standard CPR vs CC alone

\[ \text{Blood pressure} \]

\[ \text{Time} \]

\[ = \text{chest compression} \]

Berg et al, 2001
“No flow” / compression fraction

Christenson J et al, Circ 2009
poor survival with lowest compression fraction in OHCA
Chest compression depth

Survival:
- 100%
- 15%

CPR duration, min

CPP, mm Hg

2 inches vs 1.5 inches

ICCM, 2005
CPR first may improve survival

Influence of cardiopulmonary resuscitation prior to defibrillation in patients with out-of-hospital ventricular fibrillation

24% (155/639) 30% (142/478) \( p = 0.04 \)

Defib first - AHA  CPR (90 sec) first, then defib
42 months  36 months

Cobb et al, 1999
CPR first may improve survival: RCT

Wik et al., 2003

CPR first may improve survival: RCT

 Wik et al, 2003
CPR sensing and recording defibrillator

Similar defibrillators now made by both Philips and Zoll
Using CPR feedback to improve quality

Quality of out-of-hospital cardiopulmonary resuscitation with real time automated feedback: A prospective interventional study☆

Jo Kramer-Johansena,b,c, Helge Myklebustd, Lars Wika,c,e, Bob Fellowsf, Leif Svenssong, Hallstein Søreboh, Petter Andreas Steena,h

Kramer Johansen, 2006

CPR quality improvement during in-hospital cardiac arrest using a real-time audiovisual feedback system☆

Benjamin S. Abellaa,*, Dana P. Edelsonb, Salem Kima, Elizabeth Retzerc, Helge Myklebustd, Anne M. Barryc, Nicholas O’Hearne, Terry L. Vanden Hoekc, Lance B. Beckera

Abella, 2007
Actual arrest transcript: U of C, 2004

- ventilations
- rhythm check
- ECG
- compressions
- ECG: v tach
- ECG: v fib
- shock given

03:10
Chest compression rates

Abella et al, 2005
Chest compression rates by survival

Abella et al, 2005

Mean rate, ROSC group
90 ± 17 *

Mean rate, no ROSC group
79 ± 18 *

p=0.003
CPR renaissance: measuring CPR

Interruptions of Chest Compressions During Emergency

Quality of Cardiopulmonary Resuscitation During Out-of-Hospital Cardiac Arrest

Quality of Cardiopulmonary Resuscitation

Hyperventilation-Induced Hypotension During Cardiopulmonary Resuscitation

Valenzuela et al, Circ 2005
Wik et al, JAMA 2005
Abella et al, JAMA 2005
Aufderheide et al, Circ 2004
Hyperventilation during EMS resuscitation

Mean ventilation rate: $30 \pm 3.2$

First group: $37 \pm 4$ → after retraining: $22 \pm 3$

Aufderheide et al, 2004
Chest compression pauses before shocks

Pause before shock
Dose-effect of pre-shock pauses

VF removed, percent

Pre-shock pause, seconds

≤10.3 (n=10) 10.5-13.9 (n=11) 14.4-30.4 (n=11) ≥33.2 (n=10)

90% 64% 55% 10%

p=0.003

Edelson et al, 2006
Shock success by compression depth

Shock success, percent

<table>
<thead>
<tr>
<th>Compression depth, inches</th>
<th>Shock success</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>50%</td>
<td>10</td>
</tr>
<tr>
<td>1-1.5</td>
<td>62%</td>
<td>13</td>
</tr>
<tr>
<td>1.5-2</td>
<td>93%</td>
<td>14</td>
</tr>
<tr>
<td>&gt;2</td>
<td>100%</td>
<td>5</td>
</tr>
</tbody>
</table>

p=0.02

Edelson et al, 2006
Possible model underlying these data
Additional rescuer factor: fatigue

May represent fatiguing
Mean CC rate over consecutive 30 sec segments

Sugerman et al, Resusc 2009

p=NS
Mean CC depth over consecutive 30 sec segments

Sugerman et al, Resusc 2009

\[ p = 0.002 \]
Current CPR quality: summary

1. Slow compression rates
2. Frequent and lengthy pauses
3. Shallow compressions
4. Hyperventilation
The problem with cardiac arrest
The military solution
Debriefing intervention

- Code review investigation:
  - All residents and students rotating through resuscitation team roles
  - Debrief teams on their events
  - Weekly 30-45 min resuscitation debriefing/teaching sessions
Median compression rate by group

ACLS guidelines: 100/min

p=0.39

p=0.005

Edelson et al, 2008
Return of spontaneous circulation

P=0.04

Baseline: 40%
Feedback: 45%
Feedback +: 59%

Edelson et al, 2008
Training effect confirmed by Dine et al. 2008
Another approach: mock codes

Simulation on steroids → sudden and unannounced

Little experience or literature for this in ED setting or adult in-hospital environment

Hunt et al, 2007
CPR quality technologies

**Manual CPR support devices**
- Zoll AED, R series
- Philips MRx

**Mechanical CPR devices**
- Zoll Autopulse
- LUCAS
## Autopulse data

**Ong et al, 2006**

**Out-of-hospital, Richmond, VA (one site)**

<table>
<thead>
<tr>
<th></th>
<th>Manual</th>
<th>Autopulse</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROSC</td>
<td>101/499 (20.2%)</td>
<td>96/278 (34.5%)</td>
</tr>
<tr>
<td>Admitted</td>
<td>54/485 (11.1%)</td>
<td>58/277 (20.9%)</td>
</tr>
<tr>
<td>D/C</td>
<td>14/486 (2.9%)</td>
<td>27/278 (9.7%)</td>
</tr>
</tbody>
</table>
Autopulse data: RCT

**Hallstrom et al, 2006 (ASPIRE)**

**Out-of-hospital, multicenter RCT - US, Canada**

<table>
<thead>
<tr>
<th></th>
<th>Manual</th>
<th>Autopulse</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROSC</td>
<td>92/373 (24.7%)</td>
<td>104/394 (26.4%)</td>
</tr>
<tr>
<td>D/C</td>
<td>37/373 (9.9%)</td>
<td>23/394 (5.8%)</td>
</tr>
</tbody>
</table>
CPR in the workplace

Friday, June 13, 2008

Tim Russert, TV correspondent

Known asymptomatic coronary dz

Suffered AMI → cardiac arrest

Attempted resuscitation (CPR and defibrillation) failed

Unknown CPR quality or pre-shock pause time
CPR in the home

Friday, June 25, 2009

Michael Jackson died at home

Respiratory arrest from drug OD

Attempted resuscitation (CPR and defibrillation) failed

CPR performed in the bed - questionable quality, pauses in performance?
Full circle: chest compressions alone?

The New York Times
March 17, 2007

Detailed study by Ken Nagao et al (Japan)
Evaluated “standard” CPR vs cc alone

Important to note: - bystander CPR
- done in 2002-2003
- not randomized
- CPR unmeasured
Japanese bystander CPR study

- Cardiac only (n=100)
- Conventional CPR (n=166)

Effect especially noted in:
- v fib / v tach patients
- shorter call times

SOS-KANTO et al, 2007
Improving EMS care with “CC only”

Minimally Interrupted Cardiac Resuscitation by Emergency Medical Services for Out-of-Hospital Cardiac Arrest

Bentley J. Bobrow, MD
Lani L. Clark, BS
Cardon A. Four, MD

Context Out-of-hospital cardiac arrest is a major public health problem.

Objective To investigate whether the survival of patients with out-of-hospital cardiac arrest would improve with minimally interrupted cardiac resuscitation (MIRC).

Interventions:
1. Significantly delay intubation
2. 200 compressions before first shock
3. Minimize pre and post shock pauses

Tripled survival to hospital discharge (3.8% → 9.1%)
Confirmation of this finding:

**Improved Patient Survival Using a Modified Resuscitation Protocol for Out-of-Hospital Cardiac Arrest**

Alex G. Garza, MD, MPH; Matthew C. Gratton, MD; Joseph A. Salomone, MD; Daniel Lindholm, EMTP, MICT; James McElroy, EMTP, MICT; Rex Archer, MD, MPH

**Table 2. ROSC and Survivors, Witnessed VF Patient Population**

<table>
<thead>
<tr>
<th></th>
<th>Preprotocol Cohort, n (%)</th>
<th>Postprotocol Cohort, n (%)</th>
<th>Unadjusted OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Witnessed VF</td>
<td>143</td>
<td>57</td>
<td>NA</td>
</tr>
<tr>
<td>ROSC</td>
<td>54 (37.8)</td>
<td>34 (59.6)</td>
<td>2.44 (1.24–4.80)</td>
</tr>
<tr>
<td>Discharge alive</td>
<td>32 (22.4)</td>
<td>25 (43.9)</td>
<td>2.71 (1.34–5.49)</td>
</tr>
</tbody>
</table>

OR indicates odds ratio; VF, ventricular fibrillation; and ROSC, return of spontaneous circulation.
The key importance of CPR

Reflected in the poor impact of ACLS meds:

**Intravenous Drug Administration During Out-of-Hospital Cardiac Arrest**
A Randomized Trial

Theresa M. Olasveengen, MD
Kjetil Sunde, MD, PhD
Cathrine Brumborg, MSc
Jon Thowsen
Petter A. Steen, MD, PhD
Lars Wik, MD, PhD

**Context**
Intravenous access and drug administration are included in advanced cardiac life support (ACLS) guidelines despite a lack of evidence for improved outcomes. Epinephrine was an independent predictor of poor outcome in a large epidemiological study, possibly due to toxicity of the drug or cardiopulmonary resuscitation (CPR) interruptions secondary to establishing an intravenous line and drug administration.

**Objective**
To determine whether removing intravenous drug administration from an ACLS protocol would improve survival to hospital discharge after out-of-hospital cardiac arrest.

Randomized trial of epinephrine versus no epinephrine For EMS treated cardiac arrest → NO SURVIVAL BENEFIT!
Impact on CPR guidelines in future

Next guidelines update: 2010

What might change:

1. Increasing emphasis on compression-only for both bystanders and dispatch-assisted

2. Improved techniques for dispatch assisted: video-phone? Simplified protocols?

3. Improved mechanical devices for EMS
Why this is so relevant

Residents feel unprepared and unsupervised as leaders of cardiac arrest teams in teaching hospitals: A survey of internal medicine residents

Chris W. Hayes, MD, MSc; Augustine Rhee, MD; Michael E. Detsky; Vicki R. Leblanc, PhD; Randy S. Wax, MD, MEd

Critical Care Medicine, 2007

Solutions --

debriefing
simulation training
dedicated teams

Dine et al, 2008: similar survey in US, in progress
Key “take home” points

1. Cardiac arrest is not hopeless!
2. CPR quality has big impact
3. Minimize ventilations
4. Maximize chest compression rate and depth
5. Consider CPR feedback tools and code debriefing
6. Use hypothermia after cardiac arrest
The post-arrest problem

U of C in-hospital arrest data

52%

18%

hospital discharge
Reperfusion injury

Damage observed after restoration of blood flow to ischemic tissues
Modern era of hypothermia use

The New England Journal of Medicine

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INDUCED HYPOTHERMIA AFTER OUT-OF-HOSPITAL CARDIAC ARREST

Mild hypothermia induced by a helmet device: a clinical feasibility study

Said Hachimi-Idrissi *, Luc Corne, Guy Ebinger, Yvette Michotte, Luc Huysemans

Department of Critical Care Medicine and Cerebral Resuscitation Research Group, AZ-VUB, Free University of Brussels, Laarbeeklaan, 101, B-1090, Brussels, Belgium

Resuscitation 51 (2001) 275–281

Bernard, 2002

Idrissi, 2001
### Hypothermia trials: outcomes

<table>
<thead>
<tr>
<th></th>
<th>Hypothermia (%)</th>
<th>Normothermia (%)</th>
<th>RR (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alive at hospital discharge  with favourable neurological recovery</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HACA</strong></td>
<td>72/136 (53%)</td>
<td>50/137 (36%)</td>
<td>1.51 (1.14-1.89)</td>
<td>0.006</td>
</tr>
<tr>
<td><strong>Bernard</strong></td>
<td>21/43 (49%)</td>
<td>9/34 (26%)</td>
<td>1.75 (0.99-2.43)</td>
<td>0.052</td>
</tr>
<tr>
<td><strong>Idrissi</strong></td>
<td>4/16 (25%)</td>
<td>1/17 (6%)</td>
<td>4.25 (0.70-53.83)</td>
<td>0.16</td>
</tr>
<tr>
<td>Alive at 6 months with favourable neurological recovery</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HACA</strong></td>
<td>71/136 (52%)</td>
<td>50/137 (36%)</td>
<td>1.44 (1.11-1.76)</td>
<td>0.009</td>
</tr>
</tbody>
</table>
Real world usage: Switzerland

From evidence to clinical practice: Effective implementation of therapeutic hypothermia to improve patient outcome after cardiac arrest*

Mauro Oddo, MD; Marie-Denise Schaller, MD; François Feihl, MD; Vincent Ribordy, MD; Lucas Liaudet, MD

Oddo M et al, 2006

Retrospective study at one hospital in Switzerland
Cooling intervention with historical controls
Survivors of out-of-hospital arrest (n=109)
Cooling initially via ice bags, then cooling mattress
Target temperature 33°C, maintained for 24 hrs
All post-arrest ST elevations received cardiac cath
Real world usage: Switzerland

Outcome at discharge for out-of-hospital VF arrest

Baseline:
- CPC5: 56%
- CPC3: 19%
- CPC2: 12%
- CPC1: 14%

Cooling:
- CPC5: 40%
- CPC3: 5%
- CPC2: 14%
- CPC1: 42%
Real world usage: Switzerland

Outcome at discharge for out-of-hospital asystole arrest

- **Baseline**: CPC5 89%, CPC3 11%
- **Cooling**: CPC5 83%, CPC1 17%
Real world usage: Switzerland

Outcome at discharge for all rhythms with post-arrest hypotension and shock

<table>
<thead>
<tr>
<th></th>
<th>CPC5</th>
<th>CPC3</th>
</tr>
</thead>
<tbody>
<tr>
<td>baseline</td>
<td>79%</td>
<td>21%</td>
</tr>
<tr>
<td>cooling</td>
<td>71%</td>
<td>11%</td>
</tr>
</tbody>
</table>
Welcome

These pages are intended for use by physicians, nurses and other health care professionals who are interested in the care of patients after they are resuscitated from cardiac arrest. While Advanced Cardiopulmonary Life Support (ACLS) guidelines provide consensus information on the recognition and treatment of cardiac arrest in the form of "links" in the "chain of survival", the care of patients after resuscitation remains a "missing link". It is hoped that these pages will contribute towards filling this void.

At the present time, the most important specific treatment for a patient surviving cardiac arrest may be the induction of therapeutic hypothermia. A number of animal and clinical studies have supported the use of this treatment, and international guidelines have been published regarding the use of this exciting new modality.

The majority of content on these resource pages focus on therapeutic hypothermia and practical issues of how hospitals can develop protocols for use.
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Questions?