Advanced life support – What is hot and what is not in research and practice

A/Prof Peter Morley
Royal Melbourne Hospital
University of Melbourne
0845-0930
23rd September 2016
Advanced life support – What is hot and what is not in research and practice . . . lah

A/Prof Peter Morley
Royal Melbourne Hospital
University of Melbourne
0845-0930
23rd September 2016
NOTHING

- Babykiller
- Dingo
- Scorpions
- Sharks
- Stinging jellyfish

- Cyclones
- Crocodiles
- Angry natives
- Giant rats

- Backpacker
- Murderers
- Poisonous
- Snakes
- Maneating koalas
- Mosquitoes
- Sharks
- Danni Minogue
- Giant spiders

- Razor sharp coral
- Stingrays
- Steve Irwin
- Fires
- Convicts
- Deranged gunmen
The Royal Melbourne Hospital
Victoria’s first hospital opened on 15 March 1848 with 10 beds on Lonsdale Street.

Moved to current site (Parkville) on 10 December 1944
Now at the heart of the renowned Parkville Biomedical Research Precinct
"You're fired, Jack. The lab results just came back, and you tested positive for Coke."
• Potential intellectual conflicts
  – Chair Australian Resuscitation Council (ARC)
  – Australian and New Zealand Committee On Resuscitation (ANZCOR) delegate on International Liaison Committee on Resuscitation (ILCOR)
Summary

• Only really minor changes to guidelines

• Hot
  – Breathing
  – Drugs
  – Quality CPR
  – Transport to CPR centres
  – ECMO
  – Pre-arrest care
  – The formula for survival
  – Post-resuscitation care

• Not
  – Cooling (intra-arrest and pre-hospital)
Summary

• Only really minor changes to guidelines

• Hot
  – Breathing
  – Drugs
  – Quality CPR
  – Transport to CPR centres
  – ECMO
  – Pre-arrest care
  – The formula for survival
  – Post-resuscitation care

• Not
  – Cooling (intra-arrest and pre-hospital)
CPR UPDATES 2016
08:00 h – 17:00 h | 23rd May 2016
Auditorium 1, Faculty of Medicine
University Teknologi MARA (UiTM) | Sungai Buloh Campus

Malaysian Resuscitation Association (MyRA)
Seminar Highlights

ASMIC 2016
Shangri-La Hotel, Kuala Lumpur
23 - 25 September 2016
REVIEW ARTICLE

Review article: Updated resuscitation guidelines for 2016: A summary of the Australian and New Zealand Committee on Resuscitation recommendations

Peter LEMAN\textsuperscript{1,2,5} and Peter MORLEY\textsuperscript{3,4,5}

\textsuperscript{1}Emergency Department, Fiona Stanley Hospital, Perth, Western Australia, Australia, \textsuperscript{2}School of Medicine and Pharmacology, The University of Western Australia, Perth, Western Australia, Australia, \textsuperscript{3}Intensive Care Unit, Royal Melbourne Hospital, Melbourne, Victoria, Australia, \textsuperscript{4}Department of Medicine, Faculty of Medicine, Dentistry and Health Sciences, The University of Melbourne, Melbourne, Victoria, Australia, and \textsuperscript{5}Australian Resuscitation Council, Melbourne, Victoria, Australia
We had to change a few words!
Basic Life Support

D
Dangers?

R
Responsive?

S
Send for help

A
Open Airway

B
Normal Breathing?

C
Start CPR
30 compressions : 2 breaths

D
Attach Defibrillator (AED)
as soon as available, follow prompts

Continue CPR until responsiveness or normal breathing return
Advanced Life Support for Adults

Start CPR
- 30 compressions: 2 breaths
- Minimise Interruptions

Attach Defibrillator / Monitor

Assess Rhythm

Shockable
- Shock
- CPR for 2 minutes

Non Shockable
- Return of Spontaneous Circulation?
- CPR for 2 minutes

Post Resuscitation Care

During CPR
- Airway adjuncts (LMA / ETT)
- Oxygen
- Waveform capnography
- IV / IO access
- Plan actions before interrupting compressions (e.g. charge manual defibrillator)

Drugs
- **Shockable**
  - Adrenaline 1 mg after 2nd shock (then every 2nd loop)
  - Amiodarone 300mg after 3 shocks
- **Non Shockable**
  - Adrenaline 1 mg immediately (then every 2nd loop)

Consider and Correct
- Hypoxia
- Hypovolaemia
- Hyper / hypokalaemia / metabolic disorders
- Hypothermia / hyperthermia
- Tension pneumothorax
- Tamponade
- Toxins
- Thrombosis (pulmonary / coronary)

Post Resuscitation Care
- Re-evaluate ABCDE
- 12 lead ECG
- Treat precipitating causes
- Aim for: SpO2 94-98%, normocapnia and normoglycaemia
- Targeted temperature management
Key findings

- The Australian and New Zealand Committee on Resuscitation released updated resuscitation guidelines in January 2016.
- Major changes in ALS include allowing escalating defibrillation energies, commencing at 200 J in adults. No drug therapies were changed.
- BLS now recommends chest compression rate to 100–120/min, rather than 100/min.
- The routine use of semi-rigid cervical collars in pre-hospital transport is not recommended.
Summary

- Only really minor changes to guidelines

- **Hot**
  - Breathing
  - Drugs
  - Quality CPR
  - Transport to CPR centres
  - ECMO
  - Pre-arrest care
  - The formula for survival
  - *Post-resuscitation care*

- **Not**
  - Cooling (intra-arrest and pre-hospital)
Death by hyperventilation!

Death by hyperventilation: A common and life-threatening problem during cardiopulmonary resuscitation

Tom P. Aufderheide, MD; Keith G. Lurie, MD

Crit Care Med
2004; 32[Suppl.]:S345–S351
A clinical observational study analysing the factors associated with hyperventilation during actual cardiopulmonary resuscitation in the emergency department

Sang O Park\textsuperscript{a}, Dong Hyuk Shin\textsuperscript{b}, Kwang Je Baek\textsuperscript{a}, Dae Young Hong\textsuperscript{a}, Eun Jung Kim\textsuperscript{c}, Sang Chul Kim\textsuperscript{d}, Kyeong Ryong Lee\textsuperscript{a,}\textsuperscript{*}

Experienced $=$ resus team member $> 1$ y

Proper ventilation $= 8–10$

Hypoventilation $= \leq 7$

Hyper ventilation $= > 10$

Severe hypervent $= > 20$

55 adult CPR cases

673 min sectors
So slow down, but should we pause?
• **114 EMS** agencies grouped into 47 clusters
• Clusters randomly assigned to:
  – Continuous chest compressions and 10 ventilations per minute for 3 cycles
  – 30:2 for 3 cycles
• Before first analysis - chest compressions for 30 s or 2 min; oropharyngeal airway inserted
• Advanced airway delayed until after ROSC or 3 cycles of chest compressions
• Cross over twice per year
Chest compression fraction 0.83 versus 0.77 (<0.001)
# Trial of Continuous or Interrupted Chest Compressions during CPR

**Table 3. Outcomes in Patients Included in the Primary Analysis.**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Intervention Group (N=12,653)</th>
<th>Control Group (N=11,058)</th>
<th>Adjusted Difference (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Effectiveness population</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary outcome: survival to discharge — no./total no. (%)</td>
<td>1,129/12,613 (9.0)</td>
<td>1072/11,035 (9.7)</td>
<td>-0.7 (-1.5 to 0.1)</td>
<td>0.07</td>
</tr>
<tr>
<td>Transport to hospital — no. (%)</td>
<td>6686 (52.8)</td>
<td>6066 (54.9)</td>
<td>-2.0 (-3.6 to -0.5)</td>
<td>0.01</td>
</tr>
<tr>
<td>Return of spontaneous circulation at ED arrival — no./total no. (%)</td>
<td>3,058/12,646 (24.2)</td>
<td>2799/11,051 (25.3)</td>
<td>-1.1 (-2.4 to 0.1)</td>
<td>0.07</td>
</tr>
<tr>
<td>Admission to hospital — no./total no. (%)</td>
<td>3,108/12,653 (24.6)</td>
<td>2860/11,058 (25.9)</td>
<td>-1.3 (-2.4 to -0.2)</td>
<td>0.03</td>
</tr>
<tr>
<td>Survival to 24 hr — no./total no. (%)</td>
<td>2,816/12,614 (22.3)</td>
<td>2569/11,031 (23.3)</td>
<td>-1.0 (-2.1 to 0.2)</td>
<td>0.10</td>
</tr>
<tr>
<td>Hospital-free survival — days†</td>
<td>1.3±5.0</td>
<td>1.5±5.3</td>
<td>-0.2 (-0.3 to -0.1)</td>
<td>0.004</td>
</tr>
<tr>
<td>Discharge home — no./total no. (%)</td>
<td>844/12,613 (6.7)</td>
<td>794/11,034 (7.2)</td>
<td>-0.5 (-1.2 to 0.2)</td>
<td>0.15</td>
</tr>
<tr>
<td>Modified Rankin scale score‡</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤3 — no./total no. (%)</td>
<td>883/12,560 (7.0)</td>
<td>844/10,995 (7.7)</td>
<td>-0.6 (-1.4 to 0.1)</td>
<td>0.09</td>
</tr>
<tr>
<td><strong>Prespecified per-protocol analysis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment determined by automated algorithm — no./total no. (%)</td>
<td>497/6529 (7.6)</td>
<td>353/3678 (9.6)</td>
<td>-2.0 (-2.9 to -1.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Adjusted analysis‡</td>
<td>—</td>
<td>—</td>
<td>-1.3 (-2.5 to -0.1)</td>
<td>0.04</td>
</tr>
<tr>
<td>Post hoc per-protocol analysis: treatment determined by coordinator assessment — no./total no. (%)</td>
<td>834/9649 (8.6)</td>
<td>606/6156 (9.8)</td>
<td>-1.2 (-2.0 to -0.4)</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>
All about Goldilocks
Goldilocks principle

- Too much (too hot, too long, too high)
- Too little (too cold, too short, too low)
- Just right
Summary

• Only really minor changes to guidelines

• Hot
  – Breathing
  – Drugs
  – Quality CPR
  – Transport to CPR centres
  – ECMO
  – Pre-arrest care
  – The formula for survival
  – Post-resuscitation care

• Not
  – Cooling (intra-arrest and pre-hospital)
Epinephrine

Of course it works!?!?
The rate of hospital admission with ROSC: 32% IV vs 21% no IV, (P = 0.001)
The rate of survival to hospital discharge was: 10.5% and 9.2% (P = .61),
Survival with favorable neurological outcome: 9.8% vs 8.1% (P = .45)
Survival at 1 year: 10% vs 8% (P = .53)
The quality of CPR was comparable and within guideline recommendations
for both groups.
After adjustment for ventricular fibrillation, response interval, witnessed arrest, or
arrest in a public location, there was no significant difference in survival to
hospital discharge for the intravenous group vs the no intravenous group (adjusted
odds ratio, 1.15; 95% confidence interval, 0.69-1.91).
The study that couldn’t be done

Resuscitation 82 (2011) 1138–1143

Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

Effect of adrenaline on survival in out-of-hospital cardiac arrest: A randomised double-blind placebo-controlled trial

Ian G. Jacobs, Judith C. Finn, George A. Jelinek, Harry F. Oxer, Peter L. Thompson

a Discipline of Emergency Medicine (MS16), University of Western Australia, 35 Stirling Highway, Crawley, 6009 Western Australia, Australia
b Department of Medicine, University of Melbourne (St Vincents Hospital), Victoria Parade, Fitzroy, 3065 Melbourne, Australia
c St John Ambulance (Western Australia), PO Box 183, Belmont 6984, Western Australia, Australia
d School of Medicine and Population Health, University of Western Australia, Western Australia, Australia
e Sir Charles Gairdner Hospital, Hospital Avenue, Nedlands, 6009 Western Australia, Australia
PACA study: Perth, Australia

• double blind randomized placebo controlled trial of epinephrine in out-of-hospital cardiac arrests in Perth, Australia

• 535 enrolled patients ROSC and survival to discharge was greater with epinephrine
  – ROSC
    • 30.4% vs 11.1%; OR= 3.51 [95% CI 2.21 to 5.58]
  – Discharge
    • 4.1% vs 1.9%; OR= 2.16 [95% CI: 0.74 to 6.30]
Things we still don’t know!
RESEARCH

Time to administration of epinephrine and outcome after in-hospital cardiac arrest with non-shockable rhythms: retrospective analysis of large in-hospital data registry

Michael W Donnino director, center for resuscitation science, Justin D Salciccioli clinical research coordinator, Michael D Howell associate professor of medicine, Michael N Cocchi director, critical care quality, Brandon Giberson clinical research coordinator, Katherine Berg instructor of medicine, Shiva Gautam associate professor of medicine, Clifton Callaway executive vice chair of emergency medicine, for the American Heart Association’s Get With The Guidelines-Resuscitation Investigators

1Department of Emergency Medicine, Beth Israel Deaconess Medical Center, 1 Deaconess Road, Boston, W/CC 2, MA, 02215, USA; 2Department
Donnino et al. BMJ 2014;348

• In patients with non-shockable cardiac arrest in hospital, earlier administration of epinephrine is associated with a higher probability of return of spontaneous circulation, survival in hospital, and neurologically intact survival.
Adrenaline (epinephrine) dosing period and survival after in-hospital cardiac arrest: A retrospective review of prospectively collected data

Sam A. Warren\textsuperscript{a,b,c,*}, Ella Huszti\textsuperscript{a,b}, Steven M. Bradley\textsuperscript{b,f}, Paul S. Chan\textsuperscript{d,e}, Chris L. Bryson\textsuperscript{b,f}, Annette L. Fitzpatrick\textsuperscript{c,g,h}, Graham Nichol\textsuperscript{a,b,i}, for the American Heart Association's Get With the Guidelines-Resuscitation (National Registry of CPR) Investigators\textsuperscript{1}

\textsuperscript{a} University of Washington-Harborview Center for Prehospital Emergency Care, Seattle, WA, United States
\textsuperscript{b} Department of Medicine, Seattle, WA, United States
\textsuperscript{c} Department of Epidemiology, Seattle, WA, United States
\textsuperscript{d} Saint Luke's Mid-America Heart and Vascular Institute, Kansas City, MO, United States
\textsuperscript{e} University of Missouri-Kansas City, Kansas City, MO, United States
\textsuperscript{f} Health Services Research and Development Service, Veterans Affairs Puget Sound Health Care System, Seattle, WA, United States
\textsuperscript{g} University of Washington, Collaborative Health Studies Coordinating Center, United States
\textsuperscript{h} University of Washington, Department of Global Health, Seattle, WA, United States
\textsuperscript{i} Clinical Trial Center, Department of Biostatistics, Seattle, WA, United States

Less frequent average epinephrine dosing than recommended by consensus guidelines was associated with improved survival of in-hospital cardiac arrest
Clinical Trials Unit

PARAMEDIC2

Should adrenaline be used when someone's heart stops?

The PARAMEDIC2 trial is looking at whether adrenaline is helpful or harmful in the treatment of a cardiac arrest that occurs outside a hospital.

Answering this question will help to improve the treatment of people who have a cardiac arrest.
Antiarrhythmics
All we need is Amiodarone!

Refractory VF on arrival to hospital

No significant difference in the rate of survival to hospital discharge between cardiogenic OHCA patients with persistent ventricular fibrillation on hospital arrival treated with amiodarone or lidocaine.
Amiodarone, Lidocaine, or Placebo in Out-of-Hospital Cardiac Arrest


shock-refractory ventricular fibrillation or pulseless ventricular tachycardia after at least one shock, and vascular access: amio 300 lidocaine 120
<table>
<thead>
<tr>
<th>Outcome</th>
<th>Amiodarone (N=1539)</th>
<th>Lidocaine (N=1541)</th>
<th>Placebo (N=1573)</th>
<th>Amiodarone vs Placebo</th>
<th>Lidocaine vs Placebo</th>
<th>Amiodarone vs Lidocaine</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Survival to discharge, n (%)</strong></td>
<td>291 (19.0%)</td>
<td>282 (18.4%)</td>
<td>276 (17.6%)</td>
<td>1.4%</td>
<td>0.8%</td>
<td>0.6%</td>
</tr>
<tr>
<td>[N=1534;1531;1569]</td>
<td></td>
<td></td>
<td></td>
<td>(95% CI: -1.3%, 4.1%)</td>
<td>(95% CI: -1.9%, 3.5%)</td>
<td>(95% CI: -2.2%, 3.3%)</td>
</tr>
<tr>
<td><strong>MRS ≤ 3, n (%)</strong></td>
<td>221 (14.4%)</td>
<td>207 (13.5%)</td>
<td>217 (13.8%)</td>
<td>0.6%</td>
<td>-0.3%</td>
<td>0.9%</td>
</tr>
<tr>
<td>[N=1531;1530;1568]</td>
<td></td>
<td></td>
<td></td>
<td>(95% CI: -1.9%, 3.0%)</td>
<td>(95% CI: -2.7%, 2.1%)</td>
<td>(95% CI: -1.6%, 3.4%)</td>
</tr>
<tr>
<td><strong>Transported, n (%)</strong></td>
<td>1166 (75.8%)</td>
<td>1187 (77.0%)</td>
<td>1229 (78.1%)</td>
<td>-2.4%</td>
<td>-1.1%</td>
<td>-1.3%</td>
</tr>
<tr>
<td>[N=1539;1541;1573]</td>
<td></td>
<td></td>
<td></td>
<td>(95% CI: -5.3%, 0.6%)</td>
<td>(95% CI: -4.0%, 1.8%)</td>
<td>(95% CI: -4.3%, 1.7%)</td>
</tr>
<tr>
<td><strong>ROSC at ED arrival, n (%)</strong></td>
<td>489 (31.8%)</td>
<td>545 (35.4%)</td>
<td>516 (32.8%)</td>
<td>-1.0%</td>
<td>2.6%</td>
<td>-3.6%</td>
</tr>
<tr>
<td>[N=1539;1540;1573]</td>
<td></td>
<td></td>
<td></td>
<td>(95% CI: -4.3%, 2.3%)</td>
<td>(95% CI: -0.7%, 5.9%)</td>
<td>(95% CI: -6.9%, -0.3%)</td>
</tr>
<tr>
<td><strong>Admitted to hospital, n (%)</strong></td>
<td>593 (38.5%)</td>
<td>632 (41.0%)</td>
<td>572 (36.4%)</td>
<td>2.2%</td>
<td>4.6%</td>
<td>-2.5%</td>
</tr>
<tr>
<td>[N=1539;1541;1573]</td>
<td></td>
<td></td>
<td></td>
<td>(95% CI: -1.2%, 5.6%)</td>
<td>(95% CI: 1.2%, 8.1%)</td>
<td>(95% CI: -5.9%, 1.0%)</td>
</tr>
</tbody>
</table>
Things could always get worse...
Others
Combinations?

Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Vasopressin, Steroids, and Epinephrine and Neurologically Favorable Survival After In-Hospital Cardiac Arrest
A Randomized Clinical Trial

Spyros D. Mentzelopoulos, MD, PhD; Sotirios Malachias, MD; Christos Chamos, MD; Demetrios Konstantopoulos, MD; Theodora Ntaidou, MD; Androula Papastylianou, MD, PhD; Iosifinia Kollantzaki, MD; Maria Theodoridi, MD; Helen Ischaki, MD, PhD; Dimosthenis Makris, MD, PhD; Epaminondas Zakynthinos, MD, PhD; Elias Zintzaras, MD, PhD; Sotirios Sourlas, MD; Stavros Aloizos, MD; Spyros G. Zakynthinos, MD, PhD
Summary

• Only really minor changes to guidelines

• Hot
  – Breathing
  – Drugs
  – Quality CPR
  – Transport to CPR centres
  – ECMO
  – Pre-arrest care
  – The formula for survival
  – Post-resuscitation care

• Not
  – Cooling (intra-arrest and pre-hospital)
Experienced people are better, its all about training and experience
We are still not certain which targets for CPR are right!
Chest compression rate

• We recommend a **manual chest compression rate of 100–120/min** (strong recommendation, very-low-quality evidence).

• We consider the new evidence that has emerged since 2010 CoSTR as sufficient to suggest that the upper threshold should be limited to no more than 120/min.
Relationship Between Chest Compression Rates and Outcomes From Cardiac Arrest
Ahamed H. Idris, Danielle Guffey, Tom P. Aufderheide, Siobhan Brown, Laurie J. Morrison, Patrick Nichols, Judy Powell, Mohamud Daya, Blair L. Bigham, Dianne L. Atkins, Robert Berg, Dan Davis, Ian Stiell, George Sopko and Graham Nichol
the Resuscitation Outcomes Consortium (ROC) Investigators

Circulation. 2012;125:3004-3012; originally published online May 23, 2012;
100 – 120/min
Chest Compression Rates and Survival Following Out-of-Hospital Cardiac Arrest

Ahamed H. Idris, MD1; Danielle Guffey, MS2; Paul P. Pepe, MD3; Siobhan P. Brown, PhD2; Steven C. Brooks, MD4; Clifton W. Callaway, MD, PhD5; Jim Christenson, MD6; Daniel P. Davis, MD7; Mohamud R. Daya, MD8; Randal Gray, BS, MA Ed, NREMT-P9; Peter J. Kudenchuk, MD10; Jonathan Larsen, EMT-P11; Steve Lin, MD12; James J. Menegazzi, PhD5; Kellie Sheehan, BSN2; George Sopko, MD, MPH13; Ian Stiell, MD, MSc14; Graham Nichol, MD15; Tom P. Aufderheide, MD16; for The Resuscitation Outcomes Consortium Investigators

Crit Care Med 2015; 43:840–848

“secondary observational analysis of data from this large multicenter clinical trial”
A

Probability of Survival to Discharge

Average Chest Compression Rate

Sham ITD

100 – 120/min

B

Probability of Survival with mRS<3

Average Chest Compression Rate

Sham ITD

Unadjusted

Adjusted
Too fast

• No benefit, possibly worse outcomes
• Increased fatigue
• Associated with
  – decreased depth
  – Increased leaning
  – Cycles become too short
    • Inadequate time for CPR or drugs to work
All about Goldilocks
Goldilocks principle

• Too much (too hot, too long, too high)
• Too little (too cold, too short, too low)
• Just right
Chest compression depth

• We recommend a chest compression depth of approximately 5 cm (2 in.) (strong recommendation, low-quality evidence) while avoiding excessive chest compression depths (greater than 6 cm [greater than 2.4 in.] in an average adult) (weak recommendation, low-quality evidence) during manual CPR.

• In making this recommendation, we place a high value on the consistency with our previous recommendations given the resource implications (e.g., training, reprogramming CPR devices) of making a change, and consistency in data showing harm from compressions that are too shallow.
Survival favors deeper compressions

Survival favors shallow compressions

Survival favors deeper compressions
Published in final edited form as:


What is the Role of Chest Compression Depth during Out-of-Hospital Cardiac Arrest Resuscitation?

Ian G. Stiell,
Department of Emergency Medicine and Ottawa Hospital Research Institute, University of Ottawa, Ottawa, ON, Canada
What is the Role of Chest Compression Depth during Out-of-Hospital Cardiac Arrest Resuscitation?

Ian G. Stiell,
Department of Emergency Medicine and Ottawa Hospital Research Institute, University of Ottawa, Ottawa, ON, Canada

Published in final edited form as:

“5-6 cm”
What is the Optimal Chest Compression Depth During Out-of-Hospital Cardiac Arrest Resuscitation of Adult Patients?

Circulation. published online September 24, 2014; Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231 Copyright © 2014 American Heart Association, Inc. All rights reserved. Print ISSN: 0009-7322. Online ISSN: 1524-4539

Figure 2

Table 2. Compression Depth Measures.

<table>
<thead>
<tr>
<th>Depth (mm)</th>
<th>Survival (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;25</td>
<td>0.00</td>
</tr>
<tr>
<td>25-29</td>
<td>0.02</td>
</tr>
<tr>
<td>30-34</td>
<td>0.04</td>
</tr>
<tr>
<td>35-39</td>
<td>0.06</td>
</tr>
<tr>
<td>40-44</td>
<td>0.08</td>
</tr>
<tr>
<td>45-49</td>
<td>0.10</td>
</tr>
<tr>
<td>50-54</td>
<td>0.12</td>
</tr>
<tr>
<td>55-59</td>
<td>0.14</td>
</tr>
<tr>
<td>60-64</td>
<td>0.16</td>
</tr>
<tr>
<td>65+</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Total N=9,136

<table>
<thead>
<tr>
<th>Chest compression depth* (mm) - median (Q1, Q3)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>- mean (SD)</td>
<td></td>
</tr>
<tr>
<td>41 (35, 48)</td>
<td>41.9 (11.7)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Compression Depth Category* - % (n)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;38 mm</td>
<td>36% (3334)</td>
</tr>
<tr>
<td>38-51 mm</td>
<td>45% (4134)</td>
</tr>
<tr>
<td>&gt;51 mm</td>
<td>18% (1668)</td>
</tr>
<tr>
<td>Within Depth Range† - % (n)</td>
<td></td>
</tr>
<tr>
<td>Percent of minutes in recommended range - mean (SD)</td>
<td>60% (5461)</td>
</tr>
<tr>
<td></td>
<td>61% (39%)</td>
</tr>
</tbody>
</table>

*Average depth in mm for 10 minutes
†Average depth at least 38 mm for at least 60% of minutes with CPR process measures available.
Figure 3. A, Covariate-adjusted survival to discharge by compression depth with 95% confidence intervals (CIs). B, Covariate-adjusted survival to discharge by compression depth for men and women separately.

“5-6 cm”
Quality of Basic Life Support – A Comparison between Medical Students and Paramedics

Chest compression depth as an important quality characteristic of CPR was insufficient in almost 50% of participants, even in well trained paramedics.

ABSTRACT

Introduction: Poor survival rates after cardiac arrest can partly be explained by poor basic life support skills in medical professionals.

Aim: This study aimed to assess quality of basic life support in medical students and paramedics.

Materials and Methods: Observational study with 100 late medical students and 30 paramedics performing a 20-minute basic life support simulation in teams of two. Average frequency and absolute number of chest compressions per minute (mean ±SD), chest decompression (millimetres of compression remaining, mean ±SD), hands-off-time (seconds/minute, mean ±SD), frequency of switching positions between ventilation and chest compression (per 20 minutes) and rate of sufficient compressions (depth ≥50mm) were assessed as quality parameters of CPR.

Results: In groups A, B and C the rates of sufficiently deep chest compressions were 56%, 42% and 52%, respectively, without significant differences. Male gender and real-life CPR experience were significantly associated with deeper chest compression. Frequency and number of chest compressions were within recommended goals in at least 96% of all groups.

Conclusion: Overall, paramedics tended to show better quality of CPR compared to medical students. Though, chest compression depth as an important quality characteristic of CPR was insufficient in almost 50% of participants, even in well trained paramedics. Therefore, we suggest that an effort should be made to find better ways to educate health care professionals in BLS.
And what do the recipients of this teaching usually do in their practice??
Figure 5  Histogram for compression depth (mm). Fitted line indicates normal distribution.
The number of iatrogenic injuries in male patients was associated with chest compressions during cardiopulmonary resuscitation increased as the measured compression depth exceeded 6 cm. While there is an increased risk of complications with deeper compressions it is important to realize that the injuries were by and large not fatal.
All about Goldilocks
Goldilocks principle

- Too much (too hot, too long, too high)
- Too little (too cold, too short, too low)
- Just right
Chest compression fraction?
Chest Compression Fraction Determines Survival in Patients With Out-of-Hospital Ventricular Fibrillation
Circulation 2009;120;1241-1247; originally published online Sep 14, 2009;
Goldilocks principle

Figure 2. Survival to discharge for each category of chest compression fraction.
Clinical paper

The impact of increased chest compression fraction on return of spontaneous circulation for out-of-hospital cardiac arrest patients not in ventricular fibrillation

Fig. 2. Smoothing spline representing the unadjusted incremental probability of return of spontaneous circulation corresponding to a linear increase in chest compression fraction.

Goldilocks principle
Too much of a good thing or throwing the baby out with the bathwater?
In patients with out-of-hospital cardiac arrest, continuous chest compressions during CPR performed by EMS providers did not result in significantly higher rates of survival or favorable neurologic function than did interrupted chest compressions.
Pauses in Compressions?
Clinical paper

The impact of peri-shock pause on survival from out-of-hospital shockable cardiac arrest during the Resuscitation Outcomes Consortium PRIMED trial

Fig. 2. Plot of unadjusted survival to hospital discharge versus median shock pause interval. Survival results are shown as column plots referring to the left-side axis, categorized into 5 shock pause interval ranges, and stratified by pre-shock and post-shock pause classification. Counts of available cases for each survival estimate are shown for each shock pause interval range as line plots referring to the right-side axis.
Resuscitation Science

Association Between Chest Compression Interruptions and Clinical Outcomes of Ventricular Fibrillation Out-of-Hospital Cardiac Arrest

Tom F. Brouwer, MD; Robert G. Walker, BA; Fred W. Chapman, PhD; Rudolph W. Koster, MD, PhD

Circulation. 2015;132:1030-1037
Prolonged pauses have a negative association with survival not explained by chest compression fraction or decreased ventricular fibrillation termination rate.

Ventricular fibrillation termination was not the mechanism linking pause duration and survival.

Strategies shortening the longest pauses may improve outcome.

Circulation. 2015;132:1030-1037.
Table 2. Survival to Hospital Discharge as a Function of the Duration of the Longest Pause*

<table>
<thead>
<tr>
<th>Pause Duration, s</th>
<th>&lt;10</th>
<th>10–19</th>
<th>≥20</th>
<th>PValue†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longest preshock pause (n=294), %</td>
<td>43</td>
<td>37</td>
<td>24</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Longest postshock pause (n=311), %</td>
<td>37</td>
<td>36</td>
<td>35</td>
<td>0.69</td>
</tr>
<tr>
<td>&lt;20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longest perishock pause (n=288), %</td>
<td>45</td>
<td>24</td>
<td>27</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Longest nonshock pause (n=275), %</td>
<td>51</td>
<td>24</td>
<td>18</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Longest pause any cause (n=319), %</td>
<td>56</td>
<td>35</td>
<td>32</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

*For each category of pause, cases were included only if at least 1 of that type of pause could be fully measured.
†χ² for trend.
What about individualized care?

Different endpoints?
Variable endpoints?
Just like “special circumstances”
Patient-Centric Blood Pressure–targeted Cardiopulmonary Resuscitation Improves Survival from Cardiac Arrest

Robert M. Sutton¹, Stuart H. Friess², Maryam Y. Naim¹, Joshua W. Lampe³, George Bratinov¹, Theodore R. Weiland III¹, Mia Garuccio¹, Vinay M. Nadkarni¹, Lance B. Becker³, and Robert A. Berg¹

¹Department of Anesthesiology and Critical Care Medicine, The Children’s Hospital of Philadelphia, and ³Department of Emergency Medicine, The Hospital of the University of Pennsylvania, University of Pennsylvania Perelman School of Medicine, Philadelphia, Pennsylvania; and ²Department of Pediatrics, St. Louis Children’s Hospital, Washington University in St. Louis School of Medicine, St. Louis, Missouri

Am J Respir Crit Care Med 2014 Vol 190, Iss 11, pp 1255–1262,
**Table 1.** Rates of Survival across Treatment Groups

<table>
<thead>
<tr>
<th></th>
<th>Guideline Care (n = 10)</th>
<th>BP Care (n = 10)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any ROSC, n (%)</td>
<td>3 (33)</td>
<td>10 (100)</td>
<td>0.003</td>
</tr>
<tr>
<td>45-minute ICU survival, n (%)</td>
<td>1 (10)</td>
<td>9 (90)</td>
<td>0.001</td>
</tr>
<tr>
<td>24-hour survival, n (%)</td>
<td>0 (0)</td>
<td>8 (80)</td>
<td>0.001</td>
</tr>
<tr>
<td>Favorable neurologic outcome, n (%)</td>
<td>0 (0)</td>
<td>7 (70)</td>
<td>0.003</td>
</tr>
</tbody>
</table>

*Definition of abbreviations:* BP = blood pressure; ICU = intensive care unit; ROSC = return of spontaneous circulation.
Guideline care refers to target depth of 51 mm and standard advanced cardiac life support epinephrine dosing. BP care refers to cardiopulmonary resuscitation directed to attain a systolic blood pressure of 100 mm Hg and a coronary perfusion pressure greater than 20 mm Hg. Favorable neurologic outcome indicates swine cerebral performance category of 1 or 2.

Am J Respir Crit Care Med 2014 Vol 190, Iss 11, pp 1255–1262,
Quality CPR using feedback
CPR quality improvement during in-hospital cardiac arrest using a real-time audiovisual feedback system

Benjamin S. Abella, Dana P. Edelson, Salem Kim, Elizabeth Retzer, Helge Myklebust, Anne M. Barry, Nicholas O’Hearn, Terry L. Vanden Hoek, Lance B. Becker

a Department of Emergency Medicine, University of Pennsylvania, Philadelphia, PA 19104, USA
b Section of General Internal Medicine, University of Chicago Hospitals, Chicago, IL 60637, USA
c Section of Emergency Medicine, University of Chicago Hospitals, Chicago, IL 60637, USA
d Laerdal Medical Corporation, 4002 Stavanger, Norway
e Department of Critical Care, University of Chicago Hospitals, Chicago, IL 60637, USA
How they work

- **compression sensor** measures the acceleration of the patient’s chest during chest compressions
  - algorithm in the HeartStart MRx converts this to **compression depth**
- multifunction pads measure **chest impedance**
  - converted by ventilation algorithm to **ventilation volume**
- if parameters fall outside the “AHA guidelines”, onscreen signals and audible feedback are given.
Figure 8 - Q-CPR in Manual Defibrillation Mode: Good CPR

Ventilation icon

Compression depth target zone

Comp  cpm  No Flow sec  Vent  vpm

107  --    12

Comp
In both manikin and human studies, feedback during resuscitation can result in rescuers providing **CC parameters closer to recommendations.** There is **no evidence** that this translates into **improved patient outcomes.**
### ROSC

**Survive to hospital discharge**

#### 2.1

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Feedback ON</th>
<th>Control</th>
<th>Odds Ratio M-H, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Events</td>
<td>Total</td>
<td>Events</td>
</tr>
<tr>
<td>Abella 2007</td>
<td>45</td>
<td>101</td>
<td>22</td>
</tr>
<tr>
<td>Hostler 2011</td>
<td>361</td>
<td>815</td>
<td>345</td>
</tr>
<tr>
<td>Kramer-Johansen 2006</td>
<td>27</td>
<td>117</td>
<td>42</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>1033</strong></td>
<td><strong>1067</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total events</strong></td>
<td><strong>433</strong></td>
<td><strong>409</strong></td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: Tau² = 0.00; Chi² = 1.78, df = 2 (P = 0.41); I² = 0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 0.40 (P = 0.69)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 2.2

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Feedback ON</th>
<th>Control</th>
<th>Odds Ratio M-H, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Events</td>
<td>Total</td>
<td>Events</td>
</tr>
<tr>
<td>Abella 2007</td>
<td>9</td>
<td>101</td>
<td>5</td>
</tr>
<tr>
<td>Hostler 2011</td>
<td>92</td>
<td>815</td>
<td>96</td>
</tr>
<tr>
<td>Kramer-Johansen 2006</td>
<td>5</td>
<td>117</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>1033</strong></td>
<td><strong>1067</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total events</strong></td>
<td><strong>106</strong></td>
<td><strong>108</strong></td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: Tau² = 0.00; Chi² = 0.70, df = 2 (P = 0.71); I² = 0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 0.52 (P = 0.61)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 2.** Patient outcomes – comparison of feedback vs. control. (2.1) ROSC. (2.2) Survival to hospital discharge.
Maybe we still don’t measure the right things?
FIGURE 6. Relationship between ETCO₂ and cardiac index during open-chest cardiac massage
Quality Cardiopulmonary Resuscitation: Aspirational, But Not Enough?*

Peter T. Morley, MBBS, FRACP, FANZCA, FCICM, FERC
Royal Melbourne Hospital Clinical School
Melbourne Medical School
University of Melbourne
Melbourne, VIC, Australia

- early and appropriate defibrillation;
- early and appropriate advanced life support; and
- early and appropriate recognition and treatment of reversible underlying causes

Crit Care Med 2015
Summary

• Only really minor changes to guidelines

• Hot
  – Breathing
  – Drugs
  – Quality CPR
  – Transport to CPR centres
  – ECMO
  – Pre-arrest care
  – The formula for survival
  – Post-resuscitation care

• Not
  – Cooling (intra-arrest and pre-hospital)
Prehospital transportation to therapeutic hypothermia centers and survival from out-of-hospital cardiac arrest

Derek DeLia¹*, Henry E. Wang², Jared Kutzin³, Mark Merlin⁴, Jose Nova¹, Kristen Lloyd¹ and Joel C. Cantor¹
Post-arrest outcomes are more favorable at TH centers but these improved outcomes are not apparent until after hospital discharge. This finding may reflect superior care by TH centers in later stages of post-arrest treatment such as care provided in the intensive care unit, which has greater potential to affect longer term outcomes than initial treatment in the emergency department.
Summary

• Only really minor changes to guidelines

• **Hot**
  - Breathing
  - Drugs
  - Quality CPR
  - Transport to CPR centres
  - ECMO
  - Pre-arrest care
  - The formula for survival
  - *Post-resuscitation care*

• **Not**
  - Cooling (intra-arrest and pre-hospital)
No RCTs
Review article

Comparing extracorporeal cardiopulmonary resuscitation with conventional cardiopulmonary resuscitation: A meta-analysis☆

Su Jin Kima, Hyun Jung Kimb, Hee Young Leec, Hyeong Sik Ahnb, Sung Woo Leea,*

a Department of Emergency Medicine, College of Medicine, Korea University Hospital, Seoul, Republic of Korea
b Institute for Evidence-based Medicine, The Korean Branch of Australasian Cochrane Center, Department of Preventive Medicine, College of Medicine, Korea University, Seoul, Republic of Korea
c Center for Preventive Medicine and Public Health, Seoul National University Bundang Hospital, Gyeonggi-do, Republic of Korea
## A. Forest plot of studies reporting survival outcome

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>ECPR</th>
<th>CCPR</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.2.1 at discharge</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chen_2008</td>
<td>15</td>
<td>46</td>
<td>1.88 [0.88, 3.99]</td>
</tr>
<tr>
<td>Kim_2014</td>
<td>9</td>
<td>52</td>
<td>0.82 [0.37, 1.81]</td>
</tr>
<tr>
<td>Maekawa_2013</td>
<td>9</td>
<td>24</td>
<td>3.00 [0.92, 9.74]</td>
</tr>
<tr>
<td>Shin_2011</td>
<td>19</td>
<td>60</td>
<td>3.17 [1.36, 7.37]</td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>182</td>
<td>182</td>
<td>1.86 [0.99, 3.50]</td>
</tr>
<tr>
<td>Total events</td>
<td>52</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: Tau² = 0.21; Chi² = 6.28, df = 3 (P = 0.10); I² = 52%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 1.93 (P = 0.05)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **1.2.2 at 3 - 6 months** |      |      |                             |
| Chen_2008         | 15   | 46   | 2.14 [0.96, 4.76]           |
| Kim_2014          | 8    | 52   | 2.00 [0.64, 6.23]           |
| Maekawa_2013      | 9    | 24   | 4.50 [1.08, 18.69]          |
| Shin_2011         | 16   | 60   | 3.20 [1.25, 8.18]           |
| **Subtotal (95% CI)** | 182  | 182  | 2.60 [1.57, 4.30]           |
| Total events      | 48   | 18   |                             |
| Heterogeneity: Tau² = 0.00; Chi² = 1.20, df = 3 (P = 0.75); I² = 0% |
| Test for overall effect: Z = 3.73 (P = 0.0002) |

| **1.2.3 at 1 year** |      |      |                             |
| Chen_2008         | 9    | 46   | 1.50 [0.58, 3.87]           |
| Shin_2011         | 13   | 60   | 2.60 [0.99, 6.84]           |
| **Subtotal (95% CI)** | 106  | 106  | 1.96 [1.00, 3.87]           |
| Total events      | 22   | 11   |                             |
| Heterogeneity: Tau² = 0.00; Chi² = 0.64, df = 1 (P = 0.43); I² = 0% |
| Test for overall effect: Z = 1.95 (P = 0.05) |

Test for subarous differences: Chi² = 0.80, df = 2 (P = 0.67). I² = 0%
Clinical Paper

Refractory cardiac arrest treated with mechanical CPR, hypothermia, ECMO and early reperfusion (the CHEER trial)☆

Dion Stub c,f,g, Stephen Bernard a,b,d,*, Vincent Pellegrino a, Karen Smith b,d,e, Tony Walker d, Jayne Sheldrake a, Lisen Hockings a, James Shaw a,b,c, Stephen J. Duffy a,b,c, Aidan Burrell a,b, Peter Cameron a,b, De Villiers Smit a, David M. Kaye a,b,c

a Alfred Hospital, Australia
b Monash University, Australia
c Baker IDI Heart and Diabetes Research Institute, Australia
d Ambulance Victoria, Australia
e University of Western Australia, Australia
f University of Washington, United States
g St. Paul’s Hospital, Vancouver, Canada
Return of spontaneous circulation was achieved in 25 (96%) patients.

Median duration of ECMO support was 2 (IQR 1–5) days, with 13/24 (54%) of patients successfully weaned from ECMO support.

Survival to hospital discharge with full neurological recovery (CPC score 1) occurred in 14/26 (54%) patients.
Summary

• Only really minor changes to guidelines

• Hot
  – Breathing
  – Drugs
  – Quality CPR
  – Transport to CPR centres
  – ECMO
  – Pre-arrest care
  – The formula for survival
  – Post-resuscitation care

• Not
  – Cooling (intra-arrest and pre-hospital)
Detection of patients before arrest

Rapid response systems: a systematic review and meta-analysis

Ritesh Maharaj¹,²,³*, Ivan Raffaele² and Julia Wendon¹,²
RRS and cardiac arrests!

“If we pull this off, we’ll eat like kings.”
Results meta-analysis

- Observational and 1 cluster randomised
- The implementation of RRS has been associated with an overall reduction in hospital mortality in
  - adults (RR 0.87, 95% CI 0.81–0.95, p<0.001) and
  - paediatric (RR=0.82 95% CI 0.76–0.89).
- The rapid response system team was also associated with a reduction in cardiopulmonary arrests
  - adults (RR 0.65, 95% CI 0.61–0.70, p<0.001) and
  - paediatric (RR=0.64 95% CI 0.55–0.74).
The Royal Melbourne Hospital

Victoria’s first hospital opened on 15 March 1848 with 10 beds on Lonsdale Street.

Moved to current site (Parkville) on 10 December 1944
Now at the heart of the renowned Parkville Biomedical Research Precinct
Background

- Introduced MET to RMH in 2004
- Falling mortality from CAs
- Persistent background mortality after MET calls
Ward Cardiac Arrest outcomes 2014/5 (excluding not for resuscitation)

2015
ROSC
24/34
(70.6%)

Survive if ROSC
17/24
(70.8%)

0.4 / 1000 discharges
Cardiac arrest outcomes

• Ward cardiac arrest survival to hospital discharge
  – 17/34 (50%: 95% CI 34-66)
  – 34% in 2014

• Ward cardiac arrest by rhythm on arrival of team
  – EMD = 27 (12 survivors) 42% survival
  – VF = 5 (4 survivors) 80% survival
  – VT = 2 (1 survivor) 50% survival
Pre-MET system = RAPID
Call to parent medical team

<table>
<thead>
<tr>
<th>Call</th>
<th>SBP</th>
<th>HR</th>
<th>RR</th>
<th>SpO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAPID</td>
<td>&lt;100</td>
<td>&lt;50</td>
<td>&gt;120</td>
<td>&lt;24</td>
</tr>
<tr>
<td>MET</td>
<td>&lt;90</td>
<td>&lt;40</td>
<td>&gt;130</td>
<td>&gt;35</td>
</tr>
<tr>
<td>Code Blue</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
</tbody>
</table>

Code Blue = MET team plus some extras
METs and Ward Cardiac Arrests

Dose of MET 28 / 1000 discharges
**Benchmarking Report for The Royal Melbourne Hospital, Melbourne, Australia**

**METHOD 2014 - iSRRS**

Bench-marking against other contributing units:
- **GREEN TEXT** = Better than average
- **RED TEXT** = Worse than average

### Case mix

<table>
<thead>
<tr>
<th></th>
<th>Royal Melbourne</th>
<th>All METHOD units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of patients</td>
<td>27</td>
<td>1188</td>
</tr>
<tr>
<td>% from home</td>
<td>96</td>
<td>69</td>
</tr>
<tr>
<td>% for full active care</td>
<td>96</td>
<td>81</td>
</tr>
<tr>
<td>% Department of Medicine</td>
<td>59</td>
<td>53</td>
</tr>
<tr>
<td>% Department of Surgery</td>
<td>41</td>
<td>24</td>
</tr>
</tbody>
</table>

### Physiology

<table>
<thead>
<tr>
<th></th>
<th>Royal Melbourne</th>
<th>All METHOD units</th>
</tr>
</thead>
<tbody>
<tr>
<td>% patients with NEWS &gt;6</td>
<td>15</td>
<td>35</td>
</tr>
<tr>
<td>% patients with low conscious state</td>
<td>63</td>
<td>63</td>
</tr>
</tbody>
</table>

| % Composite MAELOR score       | 74%            | 52%             |

### Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Royal Melbourne</th>
<th>All METHOD units</th>
</tr>
</thead>
<tbody>
<tr>
<td>% admitted to ICU</td>
<td>56</td>
<td>23.9</td>
</tr>
<tr>
<td>% admitted to ICU within 4 hours</td>
<td>60</td>
<td>51.9</td>
</tr>
<tr>
<td>% improved on ward within 24 hours</td>
<td>58</td>
<td>65.0</td>
</tr>
<tr>
<td>% DNAR following call</td>
<td>15</td>
<td>26.0</td>
</tr>
<tr>
<td>% Mortality within 24hrs of MET</td>
<td>3.7</td>
<td>8.8</td>
</tr>
<tr>
<td>% Death with valid DNAR</td>
<td>100</td>
<td>57.5</td>
</tr>
</tbody>
</table>

### Diagram

- **Time from MET to ICU admission**
- **Royal Melbourne**
- **UKS Outside$**
BUT . . .
RMH Code Blue Outcome Graphs
Jan to Aug 2004

Survival Comparisons of Cardiac Arrests vs Medical Emergencies

>20% mortality

208 Medical Emergencies
37 Cardiac Arrests

<20% survival
Ward MET Survival to Hospital Discharge
2005 to 2010

Ward patients = excludes CCU, Cath. Lab, non patients and NFR patients.
Ward MET Survival to Hospital Discharge
Dec 2011/12

2012 Ward MET survival to hospital discharge = 87%

Ward patients = excludes CCU, Cath. Lab, non patients and NFR patients.
15-20% still die after MET calls!
Say ... what's a mountain goat doing way up here in a cloud bank?
Aims

• The purpose of this observational study was to clarify the factors that impact on adverse outcomes after MET calls in a quaternary teaching hospital with a well-established MET response.
Methods

• Prospective study
• Followed all inpatients who received a MET call from 3rd February 2014 to 31st May 2014
  – Not include Cardiac Arrests
• Demographics/calling criteria
• Outcomes
  – Survival to discharge (with CPC score)
  – ICU admission
  – Recurrent calls
Results

• Between February and May 2014, 364 patients had 466 MET calls
  – Forty-five patients with 72 MET calls were excluded, as they had not met a primary endpoint by the end of data collection period.

• Approximately one in six (17.3%) died in hospital

• One in 4 patents (22.8%) were subsequently admitted to ICU, usually within 24 hours
What factors made these patients more likely to die?
Factors associated with MET call mortality (OR order)

- a new LOMT after the call (OR 13.9, 95% CI 7.4-26.2);
- a pre-existing LOMT (OR 6.7 95% CI 3.5-12.7);
- subsequent MET calls (OR 3.0 95% CI 1.6-5.5);
- medical (v. surgical) admission (OR 2.6, 95% CI 1.4-4.9);
- meet MET but no MET call in the 24 hours prior to the first call (OR 2.4, 95% CI 1.1-5.0);
- subsequent admission to ICU (OR 2.3, 95% CI 1.3-4.2);
- After Hours call 2200-0700 (OR 2.2, 95% CI 1.2-3.9).
- First call upgraded to Code Blue 7/9 (78%) died
- Subsequent arrest during admission 4 (all died)
Why do patients die after a Medical Emergency Team call?

- The vast majority (59/63) of deaths (93.7%) occurred in patients with a LOMT
  - BUT 59/118 (50%) with LOMT survive to discharge
- In patients who did not have a LOMT during their hospital stay survival to discharge after a MET call was 249/253 (98.4%)
Summary

• Only really minor changes to guidelines

• Hot
  – Breathing
  – Drugs
  – Quality CPR
  – Transport to CPR centres
  – ECMO
  – Pre-arrest care
  – The formula for survival
  – Post-resuscitation care

• Not
  – Cooling (intra-arrest and pre-hospital)
Formula for survival

Table 1
Components of the formula for survival.

<table>
<thead>
<tr>
<th></th>
<th>1. Guideline quality</th>
<th>2. Efficient education of patient caregivers</th>
<th>3. A well-functioning local chain of survival</th>
<th>Patient survival relative to theoretical potential (factors multiplied)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utopia</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>=1.00</td>
</tr>
<tr>
<td>Ideal</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>~0.72</td>
</tr>
<tr>
<td>Attainable</td>
<td>0.8</td>
<td>0.9</td>
<td>0.5</td>
<td>~0.36</td>
</tr>
<tr>
<td>Actual</td>
<td>0.8</td>
<td>0.5</td>
<td>0.5</td>
<td>~0.20</td>
</tr>
</tbody>
</table>


Fig. 1. The Utstein formula for survival.

Resuscitation 84 (2013) 1487–1493
### Table 1
Components of the formula for survival.

<table>
<thead>
<tr>
<th></th>
<th>1. Guideline quality</th>
<th>2. Efficient education of patient caregivers</th>
<th>3. A well-functioning local chain of survival</th>
<th>Patient survival relative to theoretical potential (factors multiplied)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utopia</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>=1.00</td>
</tr>
<tr>
<td>Ideal</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>=0.72</td>
</tr>
<tr>
<td>Attainable</td>
<td>0.8</td>
<td>0.9</td>
<td>0.5</td>
<td>=0.36</td>
</tr>
<tr>
<td>Actual</td>
<td>0.8</td>
<td>0.5</td>
<td>0.5</td>
<td>=0.20</td>
</tr>
</tbody>
</table>


**Fig. 1.** The Utstein formula for survival.

Resuscitation 84 (2013) 1487–1493
Remember the unknown unknowns!
Association between Critical Care Physician Management and Patient Mortality in the Intensive Care Unit

Mitchell M. Levy, MD; John Rapoport, PhD; Stanley Lemeshow, PhD; Donald B. Chalfin, MD, MS; Gary Phillips, MAS; and Marion Danis, MD

Background: Critically ill patients admitted to intensive care units (ICUs) are thought to gain an added survival benefit from management by critical care physicians, but evidence of this benefit is scant.

Objective: To examine the association between hospital mortality in critically ill patients and management by critical care physicians.

Design: Retrospective analysis of a large, prospectively collected database of critically ill patients.

Setting: 123 ICUs in 100 U.S. hospitals.

Patients: 101,832 critically ill adults.

Measurements: Through use of a random-effects logistic regression, investigators compared hospital mortality between patients cared for entirely by critical care physicians and patients cared for entirely by non-critical care physicians. An expanded Simplified Acute Physiology Score was used to adjust for severity of illness, and a propensity score was used to adjust for differences in the probability of selective referral of patients to critical care physicians.

Results: Patients who received critical care management (CCM) were generally sicker, received more procedures, and had higher hospital mortality rates than those who did not receive CCM. After adjustment for severity of illness and propensity score, hospital mortality rates were higher for patients who received CCM than for those who did not. The difference in adjusted hospital mortality rates was less for patients who were sicker and who were predicted by propensity score to receive CCM.

Limitation: Residual confounders for illness severity and selection biases for CCM might exist that were inadequately assessed or recognized.

Conclusion: In a large sample of ICU patients in the United States, the odds of hospital mortality were higher for patients managed by critical care physicians than those who were not. Additional studies are needed to further evaluate these results and clarify the mechanisms by which they might occur.

For author affiliations, see end of text.

- In a large sample of ICU patients in the United States, the odds of hospital mortality were higher for patients managed by critical care physicians than those who were not.
Out-of-hospital cardiac arrest in Victoria: rural and urban outcomes

Paul A Jennings, Peter Cameron, Tony Walker, Stephen Bernard and Karen Smith

The mortality rates for heart disease outside Australian capital cities are 30% higher in men and 21% higher in women than rates in the cities, and the

ABSTRACT

Objective: To compare the survival rate from out-of-hospital cardiac arrest in rural and urban areas of Victoria, and to investigate the factors associated with these differences.

Jennings et al. MJA 2006; 185: 135–139
### 5 Factors associated with survival to hospital: multivariate analysis*

<table>
<thead>
<tr>
<th>Factor</th>
<th>OR</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance to ambulance station</td>
<td>0.87</td>
<td>0.82–0.92</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Sex (reference: female)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>0.77</td>
<td>0.61–0.98</td>
<td>0.032</td>
</tr>
<tr>
<td>Endotracheal tube (reference: no tube)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tube inserted</td>
<td>3.46</td>
<td>2.49–4.80</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Rhythm on arrival of EMS (reference: VF)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asystole</td>
<td>0.50</td>
<td>0.38–0.67</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>PEA</td>
<td>0.73</td>
<td>0.56–0.95</td>
<td>0.018</td>
</tr>
</tbody>
</table>

* Multivariate analysis of factors identified in univariate analysis for bystander-witnessed, adult cardiac arrests of presumed cardiac aetiology. EMS = emergency medical service. OR = odds ratio. PEA = pulseless electrical activity. VF = ventricular fibrillation.
3. Find $x$.

Here it is.
Don’t forget COI

- Industry sponsored studies more often had
  - **favorable efficacy results**, risk ratio (RR): 1.32 (95% confidence interval (CI): 1.21 to 1.44),
  - **favorable harms results** RR: 1.87 (95% CI: 1.54 to 2.27) and
  - **favorable conclusions** RR: 1.31 (95% CI: 1.20 to 1.44) compared with non-industry sponsored studies.
Table 1
Components of the formula for survival.

<table>
<thead>
<tr>
<th></th>
<th>1. Guideline quality</th>
<th>2. Efficient education of patient caregivers</th>
<th>3. A well-functioning local chain of survival</th>
<th>Patient survival relative to theoretical potential (factors multiplied)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utopia</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>=1.00</td>
</tr>
<tr>
<td>Ideal</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>=0.72</td>
</tr>
<tr>
<td>Attainable</td>
<td>0.8</td>
<td>0.9</td>
<td>0.5</td>
<td>=0.36</td>
</tr>
<tr>
<td>Actual</td>
<td>0.8</td>
<td>0.5</td>
<td>0.5</td>
<td>=0.20</td>
</tr>
</tbody>
</table>


Fig. 1. The Utstein formula for survival.
Education and ALS courses
General educational principles

- The right content for the individual
- Invert the classroom (Flipped classroom)
- In situ training
- Spaced education
- Testing effect
General educational principles

• The right content for the individual
• Invert the classroom (Flipped classroom)
• In situ training
• Spaced education
• Testing effect
Attention
Dog Guardians
Pick up after your
dogs. Thank you.

Attention Dogs
Grrrrr, bark, woof.
Good dog.

District of North Vancouver.
Bylaw 5981-11(i)
Content to focus on

• Team training
• Understand CRM
• Fixation errors cognitive biases
• Situational awareness
• Communication and speaking up
• Cognitive overload
  – Scenarios simple stepped up acquisition skills
  – Titrate to situation employment and expectations of individual
General educational principles

• The right content for the individual
• Invert the classroom (Flipped classroom)
• In situ training
• Spaced education
• Testing effect
Flipped classroom

- flipped classroom intentionally shifts instruction to a learner-centered model
- educational technologies such as online videos are used to deliver content outside of the classroom
- class time explores topics in greater depth and creates meaningful learning opportunities
General educational principles

• The right content for the individual
• Invert the classroom (Flipped classroom)
• In situ training
• Spaced education
• Testing effect
https://www.umc.edu/uploadedImages/UMCedu/Content/Administration/Public_Affairs/News_and_Publications/Alumni_Publications/School_of_Nursing/2012/2012-09-10/obgynsim10.jpg
In situ simulation training

• offers a method to identify latent hazards in clinical systems

• identified resource issues related to personnel, medication, and equipment
  – missing or an inability to use (eg. secondary to knowledge gaps)
A Randomized, Controlled Trial of In Situ Pediatric Advanced Life Support Recertification (“Pediatric Advanced Life Support Reconstructed”) Compared With Standard Pediatric Advanced Life Support Recertification for ICU Frontline Providers*

Hiroshi Kurosawa, MD1; Takanari Ikeyama, MD1,2; Patricia Achuff, MBA, RRT-NPS3; Madeline Perkel, MSN, CRNP4; Christine Watson, BSN, RN4; AnneMarie Monachino, MSN, RN, CPN1; Daphne Remy, MD5; Ellen Deutsch, MD1,6; Newton Buchanan1; JoDee Anderson, MD, MEd7; Robert A. Berg, MD6; Vinay M. Nadkarni, MD, MS1,6; Akira Nishisaki, MD, MSCE1,6

Crit Care Med 2014; 42:610–618

“Pediatric Advanced Life Support–reconstructed” recertification course by deconstructing the training into six 30-minute in situ simulation scenario sessions delivered over 6 months.
Feasible and more effective than standard Pediatric Advanced Life Support recertification training for skill performance
In Situ, Multidisciplinary, Simulation-Based Teamwork Training Improves Early Trauma Care

Susan Steinemann, MD, *§ Benjamin Berg, MD, † Alisha Skinner, ‡ Alexandra DiTulio, ‡ Kathleen Anzelon, CCRN, § Kara Terada, CCRN, § Catherine Oliver, MD, *§ Hao Chih Ho, MD, § and Cora Speck, MS§

*University of Hawaii, Department of Surgery; †University of Hawaii, Telehealth Research Institute; ‡John A. Burns School of Medicine; and the §Queen’s Medical Center, Honolulu, Hawaii


Human Patient Simulator-based trauma teamwork training appears to be an educational method that can impact patient care.
General educational principles

• The right content for the individual
• Invert the classroom (Flipped classroom)
• In situ training
• Spaced education
• Testing effect
Retention of BLS and ACLS Training Among Nurses

Resusc 2008; 78: 59-65
The available evidence suggests that ALS knowledge and skills decay by 6 months to 1 year after training and that skills decay faster than knowledge.
Simulation and education

Effects of monthly practice on nursing students’ CPR psychomotor skill performance

Marilyn H. Oermann, Suzan E. Kardong-Edgren, Tamara Odom-Maryon

a University of North Carolina at Chapel Hill, School of Nursing, 433 Carrington Hall, CB #7460, Chapel Hill, NC 27599-7460 USA
b Washington State University, College of Nursing, Box 1495, Spokane, WA 99210 USA

Fig. 2. Mean compression depth (in mm) by group and test out month. Mean compression depth (in mm) for experimental (6 min monthly practice) and control (no practice) groups at each reassessment time. Baseline mean is average compression depth for both groups combined immediately after CPR training.

Fig. 3. Percent of compressions with adequate depth for experimental (6 min monthly practice) and control (no practice) groups at each reassessment time. Adequate depth between 38 and 51 mm. Baseline mean is average percent of compressions with adequate depth for both groups combined immediately after CPR training.

Fig. 4. Mean ventilation volume (ml) by group and test out month. Mean ventilation volume (ml) for experimental (6 min monthly practice) and control (no practice) groups at each reassessment time. Baseline mean is average ventilation volume for both groups combined immediately after CPR training.

Fig. 5. Percent of ventilations with adequate volume by group and test out month. Percent of ventilations with adequate volume for experimental (6 min monthly practice) and control (no practice) groups at each reassessment time. Adequate volume between 500 and 900 ml. Baseline mean is average percent of ventilations with adequate volume for both groups combined immediately after CPR training.
How can we do this?
Pre-course

• Demo videos
• Key articles
• Manual
• Podcasts
• Vodcasts
• Tweets/social media
• Opportunities to practice/get involved
  – With feedback!
Post-course

• Key is spaced reminders with testing
• Supported by
  – Demo videos
  – Key articles
  – Manual
  – Podcasts
  – Vodcasts
  – Tweets/social media
  – Opportunities to practice/get involved
    • With feedback!
Spaced scenario demonstrations improve knowledge and confidence in pediatric acute illness management

Rahul Ojha\(^{1,2,*}\), Anthony Liu\(^1\), Bernard Linton Champion\(^1\), Emily Hibbert\(^1\) and Ralph Kay Heinrich Nanan\(^1\)

\(^1\) Sydney Medical School-Nepean, The University of Sydney, Sydney, NSW, Australia
\(^2\) Schulich School of Medicine and Dentistry, University of Western Ontario, London, ON, Canada
Simulation-based mock codes significantly correlate with improved pediatric patient cardiopulmonary arrest survival rates*

Pamela Andreatta, PhD; Ernest Saxton, BSN; Maureen Thompson, MSN; Gail Annich, MD

Objective: To evaluate the viability and effectiveness of a simulation-based pediatric mock code program on patient outcomes, as well as residents’ confidence in performing resuscitations. A resident’s leadership ability is integral to accurate and efficient clinical response in the successful management of cardiopulmonary arrest (CPA). Direct experience is a contributing factor to a resident’s code team leadership ability; however, opportunities to gain experience are limited by relative infrequency of pediatric arrests and code occurrences when residents are on service.

Design: Longitudinal, mixed-methods research design.

Setting: Children’s hospital at an tertiary care academic medical center.

Patients: Pediatric.

Interventions: Clinicians responsible for pediatric resuscitations responded to mock codes randomly called at increasing rates over a 48-month period, just as they would an actual CPA event. Events were recorded and used for immediate debriefing facilitated by clinical faculty to provide residents feedback about their performance.

Measurements: Self-assessment data were collected from all team members. Hospital records for pediatric CPA survival rates were examined for the study duration.

Results: Survival rates increased to approximately 50% (p = .000), correlating with the increased number of mock codes (r = .87). These results are significantly above the average national pediatric CPA survival rates and held steady for 3 consecutive years, demonstrating the stability of the program’s outcomes.

Conclusions: This study suggests that a simulation-based mock code program may significantly benefit pediatric patient CPA outcomes—applied clinical outcomes—not simply learner perceived value, increased confidence, or simulation-based outcomes. The use of mock codes as an integral part of residency programs could provide residents with the resuscitation training they require to become proficient in their practice. Future programs that incorporate transport scenarios, ambulatory care, and other outpatient settings could further benefit pediatric patients in prehospital contexts. (Pediatr Crit Care Med 2011; 12:33–38)

Key Words: simulation-based pediatric mock codes; pediatric cardiopulmonary arrest; residents’ resuscitation training; applied clinical outcomes; improved pediatric patient cardiopulmonary arrest survival rates
General educational principles

• The right content for the individual
• Invert the classroom (Flipped classroom)
• In situ training
• Spaced education
• Testing effect
The testing effect refers to the phenomenon that repeated retrieval of memories promotes better long-term retention than repeated study.
Existing 2 day ALS course

• Once every 4 years, with yearly updates!
• MCQs, old, with no feedback/discussion
• face to face
  – Series of lectures
  – Airway station
  – Randomly chosen workshops
  – Simulation based scenarios
    • By yourself, same role/expectations for all
New ARC ALS course ??

• 0-15 mins
  – Response to tweeted questions
• 15-30 mins
  – ALS scenario
• 30-45 mins
  – Debrief with coffee and cake
Training the team
Do team processes really have an effect on clinical performance? A systematic literature review

J. Schmutz* and T. Manser

Industrial Psychology and Human Factors, Department of Psychology, University of Fribourg, Rue de Faucigny 2, 1700 Fribourg, Switzerland

* Corresponding author. E-mail: jan.schmutz@unifr.ch
Restructuring the team

Finding the Key to a Better Code: Code Team Restructure to Improve Performance and Outcomes

Cynthia R. Prince, RN, CEN; Elizabeth J. Hines, BA; Po-Huang Chyou, PhD; and David J. Heegeman, MD
The code team restructure, which occurred over a 3-month period, included a defined number of code team participants, clear identification of team members and their primary responsibilities and position relative to the patient, and initiation of team training events and surprise mock codes (simulations).

The average time-to-defibrillation during real codes decreased each year since the code team restructure.
MET Team Training

- Introduction to Crisis Resource Management
- Principles of effective teamwork and communication
- A didactic lecture and small group discussion was followed by two immersive MET simulation scenarios with subsequent debriefing.
  - Cardiovascular collapse - Unstable RAF
  - Obstructed airway post thyroidectomy
Team Emergency Assessment Measure (TEAM)

**Introduction**

This form has been designed as a teamwork observational scale to assess the performance of emergency medical teams (e.g. resuscitation and trauma teams). The form should be completed by expert clinicians to enable accurate performance rating and feedback of leadership, teamwork, situation awareness and task management. Rating prompts are included where applicable. Please rate the first 11 items using the following scale and the last item using the 10 point scale.

<table>
<thead>
<tr>
<th>Never/Hardly ever</th>
<th>Seldom</th>
<th>About as often as not</th>
<th>Often</th>
<th>Always/Nearly always</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**Team Identification**

Date ___________ Time ___________ Place ___________

Team Leader ___________ Team ___________

**Leadership:** It is assumed that the leader is either designated, has emerged, or is the most senior – if no leader emerges allocate a ‘0’ to questions 1 & 2.

1. The team leader let the team know what was expected of them through direction and command
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4

2. The team leader maintained a global perspective
   - Prompts: Monitoring clinical procedures and the environment?
   - Prompts: Remaining hands off as applicable? Appropriate delegation?
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4

**Team Work:** Ratings should include the team as a whole i.e. the leader and the team as a collective (to a greater or lesser extent).

3. The team communicated effectively
   - Prompts: Verbal, non-verbal and written forms of communication?
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4

4. The team worked together to complete tasks in a timely manner
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4

5. The team acted with composure and control
   - Prompts: Applicable emotions? Conflict management issues?
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4

6. The team morale was positive
   - Prompts: Appropriate support, confidence, spirit, optimism, determination?
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4

7. The team adapted to changing situations
   - Prompts: Adaptation within the roles of their profession?
   - Prompts: Patient deterioration? Team changes?
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4

8. The team monitored and reassessed the situation
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4

9. The team anticipated potential actions
   - Prompts: Preparation of defibrillator, drugs, airway equipment?
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4

**Task Management**

10. The team prioritised tasks
    - [ ] 1
    - [ ] 2
    - [ ] 3
    - [ ] 4

11. The team followed approved standards/guidelines
    - Prompts: Some deviation may be appropriate?
    - [ ] 1
    - [ ] 2
    - [ ] 3
    - [ ] 4

**Overall**

1 2 3 4 5 6 7 8 9 10

---

Univariate Analysis

Team Performance based on Team Leader training and number of trained MET staff at code

- Whether the team leader had undertaken team training
- Number of people in the MET at the code who undertook MET team training

![Box plots showing team performance scores for different conditions.](image)
Multivariate Analysis

Multivariate regression analysis revealed team leader training was the strongest predictor for team performance.
And we don’t do it all that often
Exposure decreasing. The typical ‘exposure’ of paramedics was 1.4 (IQR = 0.0–3.0) OHCAs per year.
Table 1  
Components of the formula for survival.

<table>
<thead>
<tr>
<th></th>
<th>1. Guideline quality</th>
<th>2. Efficient education of patient caregivers</th>
<th>3. A well-functioning local chain of survival</th>
<th>Patient survival relative to theoretical potential (factors multiplied)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utopia</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>=1.00</td>
</tr>
<tr>
<td>Ideal</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>=0.72</td>
</tr>
<tr>
<td>Attainable</td>
<td>0.8</td>
<td>0.9</td>
<td>0.5</td>
<td>=0.36</td>
</tr>
<tr>
<td>Actual</td>
<td>0.8</td>
<td>0.5</td>
<td>0.5</td>
<td>=0.20</td>
</tr>
</tbody>
</table>


Fig. 1. The Utstein formula for survival.

Resuscitation 84 (2013) 1487–1493
Examples of attributes that influence the adoption of innovations include:

1. **Environment** (policies, market structure, incentives, network structure);
2. **Organization** (structure, resources, capabilities, professional network structure);
3. **Innovation** (quality of evidence, financial attributes, modes of delivery);
4. **Implementation** (incentives, management processes, use of peer norms).
Summary

• Only really minor changes to guidelines
• Hot
  – Breathing
  – Drugs
  – Quality CPR
  – Transport to CPR centres
  – ECMO
  – Pre-arrest care
  – The formula for survival
  – Post-resuscitation care
• Not
  – Cooling (intra-arrest and pre-hospital)
Pre-hospital versus in-hospital initiation of cooling for survival and neuroprotection after out-of-hospital cardiac arrest (Review)

Arrich J, Holzer M, Havel C, Warenits AM, Herkner H
Figure 4. Forest plot of comparison: 2 Survival: pre-hospital cooling versus in-hospital cooling, outcome: 2.1 Survival.

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>pre-hospital Events</th>
<th>Total</th>
<th>In-hospital Events</th>
<th>Total</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
<th>Risk of Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bernard 2010</td>
<td>56</td>
<td>118</td>
<td>62</td>
<td>118</td>
<td>0.80 [0.68, 1.15]</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Kämäräinen 2009</td>
<td>8</td>
<td>19</td>
<td>8</td>
<td>18</td>
<td>0.95 [0.45, 1.98]</td>
<td></td>
<td>B</td>
</tr>
<tr>
<td>Kim 2014</td>
<td>299</td>
<td>688</td>
<td>249</td>
<td>678</td>
<td>1.02 [0.89, 1.17]</td>
<td></td>
<td>C</td>
</tr>
<tr>
<td>Kim 2007</td>
<td>21</td>
<td>63</td>
<td>18</td>
<td>62</td>
<td>1.15 [0.88, 1.54]</td>
<td></td>
<td>D</td>
</tr>
<tr>
<td>Castren 2010</td>
<td>14</td>
<td>93</td>
<td>13</td>
<td>101</td>
<td>1.17 [0.58, 2.36]</td>
<td></td>
<td>E</td>
</tr>
<tr>
<td>Debaty 2014</td>
<td>7</td>
<td>123</td>
<td>5</td>
<td>122</td>
<td>1.39 [0.45, 4.28]</td>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Bernard 2012</td>
<td>10</td>
<td>82</td>
<td>7</td>
<td>81</td>
<td>1.65 [0.63, 4.80]</td>
<td></td>
<td>G</td>
</tr>
</tbody>
</table>

Risk of bias legend:
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias): Survival
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Figure 5. Forest plot of comparison: 1 Neurological outcome: pre-hospital cooling versus in-hospital cooling, outcome: 1.1 Good neurological outcome.

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>pre-hospital Events</th>
<th>Total</th>
<th>In-hospital Events</th>
<th>Total</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
<th>Risk Ratio M-H, Fixed, 95% CI</th>
<th>Risk of Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bernard 2010</td>
<td>56</td>
<td>118</td>
<td>61</td>
<td>118</td>
<td>0.80 [0.70, 1.17]</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Kämäräinen 2009</td>
<td>8</td>
<td>19</td>
<td>8</td>
<td>18</td>
<td>0.95 [0.45, 1.98]</td>
<td></td>
<td>B</td>
</tr>
<tr>
<td>Kim 2014</td>
<td>225</td>
<td>688</td>
<td>221</td>
<td>671</td>
<td>0.99 [0.85, 1.16]</td>
<td></td>
<td>C</td>
</tr>
<tr>
<td>Kim 2007</td>
<td>19</td>
<td>63</td>
<td>16</td>
<td>62</td>
<td>1.17 [0.88, 1.56]</td>
<td></td>
<td>D</td>
</tr>
<tr>
<td>Castren 2010</td>
<td>11</td>
<td>93</td>
<td>9</td>
<td>101</td>
<td>1.33 [0.58, 3.06]</td>
<td></td>
<td>E</td>
</tr>
<tr>
<td>Bernard 2012</td>
<td>10</td>
<td>82</td>
<td>7</td>
<td>81</td>
<td>1.41 [0.55, 3.93]</td>
<td></td>
<td>F</td>
</tr>
<tr>
<td>Debaty 2014</td>
<td>7</td>
<td>123</td>
<td>4</td>
<td>122</td>
<td>1.74 [0.52, 5.78]</td>
<td></td>
<td>G</td>
</tr>
</tbody>
</table>

Risk of bias legend:
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias): Good neurological outcome
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias
Induction of Therapeutic Hypothermia During Out-of-Hospital Cardiac Arrest Using a Rapid Infusion of Cold Saline
The RINSE Trial (Rapid Infusion of Cold Normal Saline)

BACKGROUND: Patients successfully resuscitated by paramedics from out-of-hospital cardiac arrest often have severe neurologic injury. Laboratory and observational clinical reports have suggested that induction of therapeutic hypothermia during cardiopulmonary resuscitation (CPR) may improve neurologic outcomes. One technique for induction of mild therapeutic hypothermia during CPR is a rapid infusion of large-volume cold crystalloid fluid.

METHODS: In this multicenter, randomized, controlled trial we assigned adults with out-of-hospital cardiac arrest undergoing CPR to either a rapid intravenous infusion of up to 2 L of cold saline or standard care. The primary outcome measure was survival at hospital discharge; secondary end points included return of a spontaneous circulation. The trial was...
In adults with OHCA, induction of mild therapeutic hypothermia using a rapid infusion of large-volume, intravenous cold saline during CPR may decrease the rate of ROSC in patients with an initial shockable rhythm and produced no trend towards improved outcomes at hospital discharge. Circulation. 2016;134:797–805
Summary

• Only really minor changes to guidelines

• Hot
  – Breathing
  – Drugs
  – Quality CPR
  – Transport to CPR centres
  – ECMO
  – Pre-arrest care
  – The formula for survival
  – Post-resuscitation care

• Not
  – Cooling (intra-arrest and pre-hospital)
What is George W Bush's first name?

A: Peter  B: Edmund  C: Torben  D: George
Summary

• Only really minor changes to guidelines

• Hot
  – Breathing: enough
  – Drugs: still not sure, but stick with guidelines
  – Quality CPR: seems obvious, hard to prove
  – Transport to CPR centres: probably coming, like trauma
  – ECMO: expensive, but promising
  – Pre-arrest care: makes sense but understand what you are doing
  – The formula for survival: education and translation are key
  – Post-resuscitation care

• Not
  – Cooling (intra-arrest and pre-hospital): not worth the effort