CPR: Role of adrenaline –
Role of monitoring (etCO2) and mechanical devices.

Tobias Graf
University Heart Center Luebeck, Germany
DECLARATION OF INTEREST

- I have nothing to declare
CPR: Role of adrenaline?

What do the ERC guidelines say?
ERC Guidelines for Resuscitation

Advanced Life Support

1. Unresponsive and not breathing normally?
   - Call Resuscitation Team

2. CPR 30:2
   - Attach defibrillator/monitor
   - Minimise Interruptions

3. Assess rhythm
   - Shockable (VF/Pulseless VT)
     - 1 Shock
     - Minimise interruptions
     - Immediately resume CPR for 2 min
     - Minimise interruptions

   - Non-shockable (PEA/Asystole)
     - Return of spontaneous circulation
     - Immediately resume CPR for 2 min
     - Minimise interruptions

Immediate Post-CARDIAC ARREST TREATMENT
- Use ABCDE approach
- Aim for SaO₂ of 94-98%
- Aim for normal PaCO₂
- 12-lead ECG
- Treat precipitating cause
- Targeted temperature management

Soar et al. Resuscitation 2015
CPR: Role of adrenaline?

**DURING CPR**
- Ensure high quality chest compressions
- Minimise interruptions to compressions
- Give oxygen
- Use waveform capnography
- Continuous compressions when advanced airway in place
- Vascular access (intravenous or intraosseous)
- Give adrenaline every 3-5 min
- Give amiodarone after 3 shocks

**If IV/IO access has been obtained, during the next 2 min of CPR give adrenaline 1 mg and amiodarone 300 mg.**

CPR: Role of adrenaline?

Evidence?
CPR: Role of adrenaline?

1:1 randomized, double blind, placebo controlled trial of adrenalin administration in OHCA patients in AUS

Jacobs et al. Resuscitation 2011
CPR: Role of adrenaline?

Jacobs et al. Resuscitation 2011

- increased portion of patients with ROSC and admission to hospital after OHCA

- adrenaline failed to demonstrate improved hospital survival and neurological outcome

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Placebo (n = 262), n (%)</th>
<th>Adrenaline (n = 272), n (%)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROSC achieved pre-hospital</td>
<td>22 (8.4%)</td>
<td>64 (23.5%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Admitted to hospital</td>
<td>34 (13.0%)</td>
<td>69 (25.4%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Survived to hospital discharge</td>
<td>5 (1.9%)</td>
<td>11 (4.0%)</td>
<td>0.15</td>
</tr>
<tr>
<td>CPC 1 or 2</td>
<td>5 (100%)</td>
<td>9 (81.8%)</td>
<td>0.31</td>
</tr>
</tbody>
</table>
CPR: Role of adrenaline?

Dose related effects?
i.e. 10fold higher doses

Lin et al. Resuscitation 2014
CPR: Role of adrenaline?

### Survival to discharge

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>SDA Events</th>
<th>Total</th>
<th>HDA Events</th>
<th>Total</th>
<th>Weight</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown 1992</td>
<td>26</td>
<td>632</td>
<td>31</td>
<td>648</td>
<td>37.9%</td>
<td>0.86 [0.52, 1.43]</td>
<td></td>
</tr>
<tr>
<td>Callaham 1992</td>
<td>3</td>
<td>270</td>
<td>10</td>
<td>286</td>
<td>4.9%</td>
<td>0.64 [0.15, 2.63]</td>
<td></td>
</tr>
<tr>
<td>Gueugniaud 1998</td>
<td>46</td>
<td>1650</td>
<td>38</td>
<td>1677</td>
<td>54.7%</td>
<td>1.23 [0.80, 1.88]</td>
<td></td>
</tr>
<tr>
<td>Sherman 1997</td>
<td>0</td>
<td>62</td>
<td>0</td>
<td>78</td>
<td></td>
<td>Not estimable</td>
<td></td>
</tr>
<tr>
<td>Stiell 1992</td>
<td>2</td>
<td>165</td>
<td>2</td>
<td>170</td>
<td>2.6%</td>
<td>1.03 [0.15, 7.23]</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>2779</td>
<td></td>
<td>2859</td>
<td></td>
<td>100.0%</td>
<td>1.04 [0.76, 1.42]</td>
<td></td>
</tr>
<tr>
<td>Total events</td>
<td>77</td>
<td></td>
<td>76</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: $\tau^2=0.00$; $\chi^2=1.60$, df $=3$ ($P=0.66$); $I^2=0$

Test for overall effect: $Z=0.22$ ($P=0.83$)

### CPC 1-2

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>SDA Events</th>
<th>Total</th>
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<tr>
<td>Callaham 1992</td>
<td>2</td>
<td>270</td>
<td>0</td>
<td>286</td>
<td>2.6%</td>
<td>5.30 [0.26, 109.80]</td>
<td></td>
</tr>
<tr>
<td>Gueugniaud 1998</td>
<td>33</td>
<td>1650</td>
<td>29</td>
<td>1677</td>
<td>97.4%</td>
<td>1.16 [0.71, 1.90]</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>1920</td>
<td></td>
<td>1963</td>
<td></td>
<td>100.0%</td>
<td>1.20 [0.74, 1.96]</td>
<td></td>
</tr>
<tr>
<td>Total events</td>
<td>35</td>
<td></td>
<td>29</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: $\tau^2=0.00$; $\chi^2=0.95$, df $=1$ ($P=0.33$); $I^2=0$

Test for overall effect: $Z=0.74$ ($P=0.46$)
CPR: Role of adrenaline?

• Part of guideline recommended therapy in ALS

• Increases ROSC and hospital admission

• Fails to demonstrate improvement in survival at hospital discharge and neurological outcome

• Further RCT needed (PARAMEDIC-2 trial ongoing 8000 patients)
CPR: Role of etCO$_2$
CPR: Role of etCO$_2$

An abrupt increase in PETCO$_2$ may indicate return of spontaneous circulation (ROSC). Increase in pulmonary circulation brings more CO$_2$ into lungs for elimination.
CPR: Role of etCO₂

ERC Guidelines 2015:

1. Ensuring tracheal tube placement Sheak et al. Resuscitation 2015

2. Monitoring ventilation rate


4. Identifying ROSC under CPR
CPR: Role of $\text{etCO}_2$

ERC Guidelines 2015
CPR: Role of etCO$_2$

Ensuring tracheal tube placement

Appropriate documentation of confirmation of endotracheal tube position and relationship to patient outcome from in-hospital cardiac arrest

Michael P. Phelan$^a$,*, Joseph P. Ornato$^b,c$, Mary Ann Peberdy$^b,c$, Fredric M. Huestey$^a$, for the American Heart Association’s Get With The Guidelines-Resuscitation Investigators$^c$

$^a$ Emergency Services Institute, Cleveland Clinic, Cleveland Clinic Lerner College of Medicine, Case Western Reserve University, Cleveland, OH 44195, United States
$^b$ Department of Emergency Medicine, Virginia Commonwealth University Health System, 1250 East Marshall Street, Richmond, VA 23298, United States

Resuscitation 2013
CPR: Role of etCO$_2$

Ensuring tracheal tube placement:
Get with the guidelines resuscitation Registry GWTG-R
(176.504 patients)

<table>
<thead>
<tr>
<th>ET confirmation method</th>
<th>Unadjusted OR Mean [95% CI]</th>
<th>p</th>
<th>Adjusted OR Mean [95% CI]</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Auscultation</td>
<td>0.984 [0.941, 1.028]</td>
<td>0.471</td>
<td>0.988 [0.943, 1.036]</td>
<td>0.625</td>
</tr>
<tr>
<td>$P_{etCO_2}$ or EDD</td>
<td>1.196 [1.150, 1.244]</td>
<td>0.0001</td>
<td>1.229 [1.179, 1.282]</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Phelan et al. Resuscitation 2013
CPR: Role of mechanical devices

The effect of resccuer fatigue on the quality of chest compressions

F. Javier Ochoa a,*, E. Ramalle-Gómara b,c. V. Lisa d, I. Saralegui a

![Graph showing the effect of time on chest compressions](image)

Fig. 1. The effect of the course of time on the quality of chest compressions.

CPR: Role of mechanical devices

Fig. 19. Heart Resuscitator Cardio Pulser.

Fig. 4. Iron Heart gas powered.

Fig. 17. Humlin Branson electricity powered.

Fig. 5. Bock-Burk electricity powered.

Formenta Heart-Lung Machine.

Fig. 11. Hopee Cardiac Masager.

Wik, Resuscitation 2000
CPR: Role of mechanical devices

Acute compression decompression device (ACD) LUCAS II

Load distribution band device AutoPulse
CPR: Role of mechanical devices

Stehen et al., Resuscitation 2002
CPR: Role of mechanical devices

**LUCAS II in OHCA-CPR setting**

Mechanical versus manual chest compression for out-of-hospital cardiac arrest (PARAMEDIC): a pragmatic, cluster randomised controlled trial

Gavin D Perkins, Ranjit Lall, Tom Quinn, Charles D Deakin, Matthew W Cooke, Jessica Horton, Sarah E Lamb, Anne-Marie Slowther, Malcolm Woollard, Andy Carson, Mike Smyth, Richard Whitfield, Amanda Williams, Helen Pocock, John J M Black, John Wright, Kyee Han, Simon Gates, PARAMEDIC trial collaborators*

Lancet 2015

**Autopulse in OHCA-CPR setting**

Manual vs. integrated automatic load-distributing band CPR with equal survival after out of hospital cardiac arrest. The randomized CIRC trial☆,☆☆

Lars Wik a,*, Jan-Aage Olsen a,b, David Persse c, Fritz Sterz d, Michael Lozano Jr. e,f, Marc A. Brouwer g, Mark Westfall h,i, Chris M. Souders c, Reinhard Malzer j, Pierre M. van Grunsven k, David T. Travis e, Anne Whitehead l, Ulrich R. Herken m, E. Brooke Lerner n

Resuscitation 2014
CPR: Role of mechanical devices

### Survival to discharge or 30 days

<table>
<thead>
<tr>
<th></th>
<th>LUCAS</th>
<th>Manual</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Events</td>
<td>Total</td>
<td>Events</td>
<td>Total</td>
</tr>
<tr>
<td>Smokal 2011</td>
<td>6</td>
<td>7</td>
<td>72</td>
</tr>
<tr>
<td>LINC</td>
<td>112</td>
<td>1286</td>
<td>175</td>
</tr>
<tr>
<td>PARAMEDIC</td>
<td>104</td>
<td>1652</td>
<td>193</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>3013</td>
<td>4165</td>
<td>100.0%</td>
</tr>
<tr>
<td>Total events</td>
<td>222</td>
<td>309</td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: $\chi^2 = 4.3$, df = 2 (p = 0.11); I² = 0%
Test for overall effect: $Z = 0.49$ (p = 0.62)

### Survived event

<table>
<thead>
<tr>
<th></th>
<th>LUCAS</th>
<th>Manual</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Events</td>
<td>Total</td>
<td>Events</td>
<td>Total</td>
</tr>
<tr>
<td>Smokal 2011</td>
<td>18</td>
<td>15</td>
<td>72</td>
</tr>
<tr>
<td>LINC</td>
<td>366</td>
<td>1300</td>
<td>1289</td>
</tr>
<tr>
<td>PARAMEDIC</td>
<td>377</td>
<td>1570</td>
<td>2690</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>2945</td>
<td>4051</td>
<td>100.0%</td>
</tr>
<tr>
<td>Total events</td>
<td>761</td>
<td>1030</td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: $\chi^2 = 0.39$, df = 2 (p = 0.82); I² = 0%
Test for overall effect: $Z = 0.02$ (p = 0.99)

PARAMEDIC trial: No advantage ACD vs manual chest compression in survival

Perkins et al. Lancet 2015
CPR: Role of mechanical devices

CIRC trial: No advantage load distribution band vs. manual chest compression in survival

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>M-CPR (n = 2132)</th>
<th>iA-CPR (n = 2099)</th>
<th>Covariate adjusted odds ratio (95% CI)</th>
<th>Covariate and interim analyses adjusted odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival to Hospital</td>
<td>233 (11.0%) (7 cases unknown)</td>
<td>196 (9.4%) (5 cases unknown)</td>
<td>0.89 (0.72–1.10)</td>
<td>1.06 (0.83–1.37)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Discharge</td>
<td>532 (25.0%)</td>
<td>456 (21.8%) (10 cases unknown)</td>
<td>0.86 (0.74–0.998)&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Survival to 24 h</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sustained ROSC</td>
<td>689 (32.3%)</td>
<td>600 (28.6%)</td>
<td>0.84 (0.73–0.96)&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Discharge mRS</td>
<td>(n = 233)</td>
<td>(n = 196)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score of 0–3</td>
<td>112 (48.1%)</td>
<td>87 (44.4%)</td>
<td>0.80 (0.47–1.37)&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Score of 4–5</td>
<td>61 (26.2%)</td>
<td>50 (25.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown score</td>
<td>60 (25.8%)</td>
<td>59 (30.1%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Adjusted for covariates and interim analyses.

<sup>b</sup> Secondary outcomes can only be adjusted for the covariates, not the interim analyses.
CPR: Role of mechanical devices

Why then thinking about mechanical devices?

Paramedic systems in rural regions with complex logistics/ bridge to advanced therapies

Radiation dose reduction for CPR teams in cath lab settings
Summary

• Use of adrenalin strongly recommended despite lack of outcome data

• Use of capnography strongly recommended to monitor CPR and ROSC

• Use of mechanical devices might be considered