Usefulness of Mechanical CPR Devices

EMS Asia, Seoul
26th Aug 2016

COL (Dr) Ng Yih Yng
Chief Medical Officer, Singapore Civil Defence Force,
Chief Medical Officer, Ministry of Home Affairs
Consultant, Emergency Medicine, Tan Tock Seng Hospital
Consultant, Pre-hospital Emergency Care, Ministry of Health
Deputy Director, Unit for Pre-hospital Emergency Care, Ministry of Health

MBBS, MRCS A&E (Edin.), MPH/MBA (JHU)
Singapore & Singapore Civil Defence Force

- 5.5 million population
- 90% stay in high rise buildings
- 3 man crew (EMT-I)
- All ambulances are equipped with LUCAS 2 mechanical CPR devices since 2012
Two theories of CPR blood flow

**CARDIAC COMPRESSION PUMP**

**INTRATHORACIC PRESSURE PUMP**

**COMPRESSION**

**RELAXATION**

**PULM. CIRC.**

**RV**

**LV**

**LUNG AIR**

**C**

**RF**

**LV**
Berg et al.
Adverse Hemodynamic Effects of Interrupting Chest Compressions for Rescue Breathing During Cardiopulmonary Resuscitation for Ventricular Fibrillation Cardiac Arrest
Piston CPR (father)
ACD Resuscitator (mother)

LUCAS (son!)
Vest CPR

Autopulse
# Types of Automated Chest Devices

<table>
<thead>
<tr>
<th>Device</th>
<th>Thumper</th>
<th>Autopulse</th>
<th>Lucas 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>9kg (not including O2)</td>
<td>18kg</td>
<td>10kg</td>
</tr>
<tr>
<td>Power</td>
<td>Pneumatic 45L/min</td>
<td>Li-Ion (30mins)</td>
<td>Li-Ion (45mins)</td>
</tr>
<tr>
<td>CPR type</td>
<td>Piston</td>
<td>Load distributing band</td>
<td>Piston + Active Decompression</td>
</tr>
<tr>
<td>Cost</td>
<td>~$8k</td>
<td>~$14-15k</td>
<td>~$14-15k</td>
</tr>
</tbody>
</table>
Mechanisms

Piston CPR

LDB CPR

ACD CPR
Meta-analysis of 5 RCTs on Mechanical CPR

Table 1

<table>
<thead>
<tr>
<th>Study/year</th>
<th>Region</th>
<th>Comparison</th>
<th>No. of patients</th>
<th>Mean age (y)</th>
<th>Cardiac etiology (%)</th>
<th>Witnessed cardiac arrest (%)</th>
<th>Bystander CPR before EMS arrival (%)</th>
<th>VF/VT as initial rhythm (%)</th>
<th>Adverse events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wik et al.</td>
<td>3 US and 2 European sites</td>
<td>LDB-CPR vs M-CPR</td>
<td>4231</td>
<td>65.7 ± 16.4</td>
<td>Mechanical: 65.6 ± 16</td>
<td>Mechanical: 100 Manual: 100</td>
<td>Mechanical: 37 Manual: 37</td>
<td>Mechanical: 47 Manual: 49</td>
<td>No significant difference between groups</td>
</tr>
</tbody>
</table>

Data are presented as mean ± SD unless indicated otherwise.

UK, united kingdom; US, united states; CPR, cardiopulmonary resuscitation; PD-CPR, piston-driven CPR; LDB-CPR, load-distributing band CPR; M-CPR, manual CPR; EMS, emergency medical systems; VF, ventricular fibrillation; VT, ventricular tachycardia.

*Mean (range).

- UK, Swedish, Dutch, US and Canada data
- LDB and Piston devices
- No improvement in survival in general

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4621518/table/t1/?report=objectonly
AHA 2015

• Mechanical Piston Devices/LDB devices
  – **may be considered** in *specific settings* where the delivery of high-quality *manual compressions* may be *challenging or dangerous* for the provider
    • limited rescuers available,
    • prolonged CPR,
    • during hypothermic cardiac arrest
    • in a moving ambulance etc
  – provided that rescuers **strictly limit interruptions** in CPR during deployment and removal of the devices (Class IIb, LOE C-EO)
ERC 2015

• In addition says...
  – ...mechanical CPR should do so only within a 
    **structured, monitored programme**, which should 
    include **comprehensive competency-based training** and regular opportunities to refresh skills.
  – The use of **training drills** and ‘pit-crew’ 
    **techniques** for device deployment are suggested 
    to help **minimise interruptions** in chest compression
How many people are inside this picture helping with the cardiac arrest?
Manpower needed for Resuscitation

• 2-man CPR
• Airway management (1-2 pax)
• Fluids/Drugs (1-2 pax)
• Recording data
Mannequin study of 62 students (5mins CPR)

- % of compressions reaching correct depth
  - 1st Min: 53%
  - 5th Min: 38% (p=0.012)

- Drop of 6% in proportion of CPR>5cm deep between the 1st and 2nd min

- Mean fatigue was reported by students at 167secs

“Do more with less...”

3 man crew (+1 trainee) $\rightarrow$ 2 man crew in the future?
It’s like having 2 more staff
Manual CPR in EMS transportation

- Staff Safety
  - No seat belts
  - Back Injuries
  - Risk of Needle stick injuries
  - Back strain
Manual CPR in EMS transportation

• Care quality
  – Inconsistent CPR quality with shifting forces and fatigue
  – Impossible to do CPR when moving patient
  – Impossible to do CPR in a small lift in chair position
Vertically Challenged in Singapore

- Old high rise buildings with small lifts
- In the old days lifts did not stop at all floors!
- Single vehicle response with 3 man crew
Try to perform CPR in this elevator
In a vertical position, only Kungfu CPR will work!
Mechanical CPR – Singapore Style

- Stretchers are still loaded in reclining position for many high rise residential buildings

“Singapore Sling”
Interesting Fact! - Heads up CPR shown to raise Coronary Perfusion Pressure in animal studies


CPR Analysis

With LUCAS 2 Mechanical CPR
Criticisms of Mechanical CPR

- Longer time to setup
- Costly to buy
- Maintenance and logistics
  - Batteries
  - Servicing
- Many types of devices, which is ‘best’?
Dealing with the pitfalls of Mechanical CPR

- Pitcrew coordinated team drills
- Minimize CPR interruption
What’s ahead?

- Seamless Data Transfer
- Smaller, lighter
- Better battery life
- Circumferential vs Piston
- Synchronised ventilation and defibrillation
- Customised compression rate/depth according to blood flow response monitoring
In Summary

Training

- Coordinated Manual CPR vs Mechanical CPR
- Both need training and synchronization

Admin

- Cost of Machines
- Maintenance
- Storage on ambulance

Operations

- CPR at scene vs in movement
- CPR in tight spaces/lifts
- Manpower limitations
Questions?