CONTROL THE CHAOS

AUTOMATED CHEST COMPRESSION DEVICES

Phoenix Children's Hospital

There are over 30,000 A-CPR devices in use worldwide
>21,000 LUCAS A-CPR devices currently sold worldwide
12,500 to EMS providers
2,500 to hospitals
>10,000 Auto-Pulse devices sold worldwide
Both companies report active sales currently
Whether your program has one or not, it is likely you will see one used in the near future

SUMMER OF 2017

Rationale for automated compression devices (ACDs)
Review of commercially available ACDs
Literature review of device usage (adult and animal data)
Conclusions / recommendations

OBJECTIVES

HISTORY

1974 80/min “immediate opening of the airway”
1980 60/min “thoracic pump” 1:1 comp/release
1986 100/min Data supported 120/min but too difficult for public
thoracic pump occurs later when the pt develops a “stone heart”
15:2 ratio for ventilation remained
2000 100/min 15:2
2005 100/min 30:2
2015 100-120/min 30:2

“why is it that every time I push on his chest he opens his eyes but when I give him a breath he goes back to sleep?”

Key determinant of CPR to reestablish organ perfusion is the efficacy of external chest compressions
Coronary perfusion is critical for successful ROSC
CPP > 15 associated with higher incidence of ROSC  JAMA 1990
Gold standard for chest compressions 100-120/min at 5cm
A direct inverse relationship between duration of CC interruptions and short term survival  Circulation 2002

COMPRESSIONS VS VENTILATION
AHA GUIDELINES 2015
“HIGH QUALITY CPR”

- Rate of 100 but not faster than 120
- Chest compressions 2” but not more than 2.5” (5-6 cms)
- Allow for complete chest recoil after each compression
- Minimize interruptions in chest compressions
- Avoid excessive ventilation

PROBLEMS...

- Quality CPR is difficult to learn, difficult to perform and intimidating (esp bystanders)
- 30% insufficient rate and 40% insufficient depth
  JAMA 2005;293:305
- Drop of in performance is dramatic during the first 3 mins and after 5 min down to 18%
  Ann Emerg Med 1995;26:300
- Dependent on rescuer’s endurance – highly variable
- At best supplies 33% of cerebral BF and 20% coronary BF
- Multiple interruptions for pads, defib, breaths, transport et

Fatigue influences CPR quality before the rescuer is able to perceive it him/herself


PSYCHOLOGICAL ISSUES
RESUSCITATION. 2007 JUL;74(1):127-34

- 80% use judgement to gauge depth and rate
- 39% believe that a depth of 2” causes severe injury
- 54% feel very uncomfortable when breaking ribs during CPR
- 25% feel that the potential benefits of guideline depth could not justify the potential injury

SOLUTION?

- In an effort to improve manual CPR a number of CPR devices have been developed and are in various stages of study.
  - THUMPER mechanical piston Michigan Instruments
  - AUTO-PULSE load distributing band (LDB) Zoll
  - LUCAS mechanical piston Physio Control
AUTOPULSE
ZOLL

LUCAS 3 Chest Compression system

https://www.youtube.com/watch?v=kPSKsTWBLLQ

https://www.youtube.com/watch?v=vIDJk3fA3sU

Mechanical versus manual chest compressions for cardiac arrest (review)
Brooks SC, Hassan N, Bighem BL, Morrison LJ.
Mechanical vs manual chest compressions for cardiac arrest

3 OHCA studies

3 IHCA studies
Taylor 1978, Halperin 1993, Lu 2010

CPR guidelines have changes several times over the time frame of these studies
Could not recommend mechanical over manual CPR
LINC, CIRC, PARAMEDIC RCTs were pending at the time of publication

Manual Cardiopulmonary Resuscitation Versus CPR Including a Mechanical Chest Compression Device in Out-of-Hospital Cardiac Arrest: A Comprehensive Meta-analysis From Randomized and Observational Studies

Judith L. Barnes, MD; Marc A. Bruner, MD, PhD; Diane P. Havens, MD, PhD; Dominique V. M. Verheert, BSc; Frank W. A. Verheert, MD, PhD; Judy L. R. M. Smets, MD, PhD; Monique van den Borne, MD, PhD

ASPIRE 2006 USA/Canada A-P n=767
LINC 2014 Sweden, UK, Netherlands L n=2589
CIRC 2014 Aus, USA, Netherlands A-P n=4231
PARAMEDIC 2016 UK L n=4471
9 studies reported on survival to discharge
- 865/9568 = 9%
- No difference in outcomes between manual vs mechanical CPR

6 studies reported on neurologic outcomes
- 504/8728 = 6% favorable outcomes
- No difference in outcomes between manual vs mechanical CPR

What do we do now?
PROS

- Proven improved CBF and CorBF in animal studies
- Consistent depth and rate CPR
- Cath Lab compatible
- Provider safety
- Endurance
- Does not seem to cause patient harm

CONS

- Expensive $10-15k apiece
- Not shown to benefit the patients in RCTs
- Chest injuries occur but no different than manual CPR

AHA GUIDELINES FOR MECHANICAL CPR

General:
- "The use of mechanical CPR devices may be considered in specific settings where the delivery of high-quality manual compressions may be challenging or dangerous for the provider"

Cath Lab setting:
- "It may be reasonable to use mechanical CPR devices to provide chest compressions to patients in cardiac arrest during PCI."

POTENTIAL APPLICATIONS

- May play a role in witnessed arrest unresponsive to countershock
- Case reports suggest benefit in cath lab
- ECMO – CPR (CHEER TRIAL 2015)
- Possible other in-hospital arrest scenarios
- Situations with limited manpower or difficult access
- Provider safety such as rapid ambulance transport
- Long transport of hypothermic patient in arrest
- Prolonged cardiac arrest with reversible causes

QUESTIONS

- Are automated CPR devices available for children?
- Have RCTs shown ACDs to be more beneficial to patients than manual cpr?
- Does the AHA recommend their use in certain situations?

The End
**CARDIOCEREBRAL RESUSCITATION**

“Why is it every time I press on his chest he opens his eyes, and every time I stop to breathe for him he goes back to sleep?”

– Anonymous bystander during telephone-directed CPR

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**Bystander Cardiopulmonary Resuscitation**

Is Ventilation Necessary?

Robert A. Berg, MD; Karl B. Kern, MD; Arthur B. Sanders, MD; Charles W. Otto, MD; Ronald W. Hildeg, DVM, PhD; Gordon A. Ewy, MD

*Circulation Vol 88, No 4, Part 1 October 1993*

https://www.youtube.com/watch?v=gNjz8JoY1I1

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**CARDIOCEREBRAL RESUSCITATION**

- EMS component (unwitnessed arrest)
- Initial responder performs 200 compressions at 100/min
- Interrupted briefly for pad placement only
- Oral airway placed with NRB mask for O2
- Rhythm analysis with shock if appropriate then resume 200
- Repeated until ROSC or 8 minutes before consider LMA or intubation

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**CARDIOCEREBRAL RESUSCITATION**

Survival from simulated out-of-hospital cardiac arrest in 159 swine in six different studies

![Graph showing survival rates](image)

**Comparison of Outcome During a Simulated Single-Layer Resuscitation Scenario of Out-of-Hospital Ventricular Fibrillation Cardiac Arrest**

- CCC CPR: 73%
- Ideal CPR: 70%
- No CPR: 7%

Comparison of Outcome: CCC CPR vs Standard CPR

<table>
<thead>
<tr>
<th>Group</th>
<th>Survival Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCC CPR</td>
<td>73%</td>
</tr>
<tr>
<td>Standard CPR</td>
<td>0%</td>
</tr>
</tbody>
</table>

P < 0.003
Resuscitation research can be divided into three sequential phases post arrest:

- **Electrical VF and defibrillation**
  - AEDs have made a big impact on outcomes and are widely accepted
- **Circulatory** (if countershock is unsuccessful)
  - "good CPR" is helpful but difficult to do
  - Most pts receive suboptimal CPR esp if the resuscitation is prolonged
- **Metabolic** global ischemic damage and metabolic injury from reperfusion
  - Successful ROSC increasingly unlikely despite intervention
  - Interruption

### CARDIOPULMONARY RESUSCITATION

Important concepts and practices for the AHA Guidelines for BLS include:

- Immediate recognition of sudden cardiac arrest (SCA) by noting unresponsiveness or absent/poor respiratory breathing
- Immediate initiation of extracorporeal CPR – "push hard, push fast!" (but not too hard nor too fast)
  - with continuous attention to the quality of chest compressions, and to the frequency of ventilations
- Minimizing interruptions in CPR
- For health care professional rescuers, taking no more than 10 seconds to check for a pulse
- For single untrained rescuers, encouraging performance of extracorporeal CPR without checking for a pulse
- Using external perfusion aids as soon as available
- Activating emergency medical services as soon as possible

Patient survival depends primarily upon immediate initiation of excellent CPR and early defibrillation.