

Journal Club Synopsis
Block 2: August 19, 2014
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Mentors: Dr. Stacey Poznanski and Dr. James Olson

Vignette:

You are on a shift at GSH when a patient arrives by EMS in full arrest. CPR is in progress and is continued on arrival. Paramedics state that the patient is a 24 yo M who was found at the bottom of a community pool with estimated submersion time of 5 minutes per family members, who state that the patient was not a strong swimmer. No ROSC was attained prior to arrival. Rhythm strip demonstrates PEA. Transportation time was <5 minutes. Pt has no e/o trauma. He is not responsive to verbal/noxious stimuli. ETT has been placed pre-hospital and adequate placement is confirmed by traditional methods on arrival to the ER. ACLS algorithm is continued and an overzealous medical student has taken over chest compressions. The student appears to be performing compressions at a rate of ~150/min. The bed height is elevated and so the depth of compressions does not appear to be adequate per your assessment. You ask that the bed be lowered and instruct the student to slow their rate to 100/min and compress to a depth of 2". At this time the paramedic states, "Hey doc, we just got a mechanical compression device. Do you want me to grab it off the rig and use it?" Meanwhile, the nurse is struggling to maneuver around the patient, medical student and other staff in attempt to gain IV access and is clearly frustrated in the limited space.

What is your response? Are mechanical compression devices as effective or more effective as manual compression? When might you consider usage of these devices? Are their contraindications/limitations to usage?

Purpose/Approach:

The purpose of this journal club was to explore the literature to assess for when external mechanical compression devices might be utilized and to ascertain what level of evidence currently exists to support usage.

I searched PubMed in search of high quality studies using a variety of keywords and filters. I additionally searched the Internet for the most up-to-date AHA guidelines to determine what current recommendations existed. I chose the AHA 2010 Guidelines and Cochrane review as background articles to give readers a foundation from which to approach the chosen discussion articles. The first article for discussion was chosen because it was the most recent article I could find that was a phased cohort study and I felt gave a good representation of the bulk of the literature study-type. In my review of the literature I found that most is comprised of cohort studies, observation studies and case reports. The second article was chosen because this is the most recent and robust RCT. In fact, the most recent Cochrane review listed this article as one that was underway but had not yet been published. The third article was chosen because it intrigued me by title. I wanted to know when mechanical compression devices "made sense."

Background Information:

Commercially available devices:

Zoll AutoPulse: Load distributing band (LDB). Constricting band and half backboard. Provides compressions at rate of 80/min. Chest displacement is approximately 20% of AP diameter. Runs in mode of 30:2 or continuous compressions.



Lucas™ device: electronic piston device with suction cup. Provides compressions at depth of 2" and rate of 100/min.



Cochrane Review:

Brooks SC, Hassan N, Bigham BL, Morrison LJ. *Mechanical versus manual chest compressions for cardiac arrest (Review)*. 2014. The Cochrane Collaboration.

- 1st update. First review was in 2011. This current review was published in 2014 and literature search updated through Jan 2013.
- Background:
 - Several studies have shown compressions performed by trained professionals do not meet recommendations for rate/depth/continuity
 - One study demonstrated chest compression halted 48% of time in prehospital setting
 - Another study demonstrated rate <90bpm 27% of the time & depth too shallow 37% of time during in-hospital arrest
 - Fatigue felt to play a major role. One study demonstrating significant fatigue after only 1 minute and only 18% on correct compressions after 5 min on mannequin

- Some data from animal observational studies have shown improved cerebral, central and coronary perfusion
- Most recent phased cohort study reported OR of 2.27 for survival to hosp discharge
- Initially 1871 citations identified but only 6 were relevant. Two studies were new since the previous review. (published dates from 1978 – 2010)
- 2 authors reviewed citations and a third author resolved disagreements
- Only RCT, cluster RCTs and quasi-randomized studies were included
- Pooled n = 1166 participants
- Overall quality of studies is poor with significant heterogeneity
- Largest study found pts had lower survival with mechanical devices but felt to have problems with methods
- Two smaller studies found more pts had hearts restart, but the N was too small for validity to be clear
- One of the new studies showed more pts had heart restart and survived to hosp discharge... But the other new study showed no difference in these parameters
- Conclusion: “not enough data are available from good-quality trials to answer the question and support a recommendation on whether these machines should be used.”
- Several Large RCTs are currently underway

AHA Guidelines (2010 Update):

Highlights of the 2010 American Heart Association. *Guidelines for CPR and ECC*. 2010. American Heart Association.

- Focus from ABC to CAB
- Focus on compression depth to at least 2”
- Focus on rate of 100-120/min
- Insufficient evidence to support routine use of LDB (AutoPulse), p.12
- May consider piston devices when conventional CPR would be difficult to maintain (e.g. during diagnostic studies)
- To prevent delays and maximize efficiency, initial training, ongoing monitoring and retraining programs should be offered on frequent basis to providers using CPR devices.

Discussion Articles:

ME Ong, et al, (2012):

Ong MEH, Fook-Chong S, Annathurai A, et al. *Improved neurologically intact survival with the use of an automated, load-distributing band chest compression device for cardiac arrest presenting to the emergency department.* Critical Care. 2012; 16:R144.

- Phased, prospective cohort study
- N = 1011
- Phase 1: Jan 2004 – Aug 2007 (manual CPR); Phase 2: Aug 2007 – Dec 2009 (LDB mechanical device)
- Conducted at 2 urban hospitals
- Providers had >30 min training on manikin using the device. Focused on minimal delay in applying device, minimal interruptions, and rapid defibrillation.
- Primary outcome was survival to hospital discharge (LDB 3.3% vs Manual 1.3, OR 1.42, 95%CI 0.47 – 4.29) – not statistically significant
- Secondary outcome was survival to hospital discharge WITH good neurological outcome. Cerebral Performance Category 1 (Manual 1 vs LDB 12, p = 0.01) – statistically significant
- Secondary outcome of ROSC improved (35.3% LDB vs 22.4% manual, OR 1.89, 95%CI 1.43 – 2.5)
- **Pros:** LDB deployed per protocol while traditional CPR continued until device could be applied, monitored CPR quality, providers had good training prior to study
- **Cons:** not randomized study, not sufficiently powered to show effect in primary outcome, mechanical issues early in study and unfamiliarity of product may have skewed data, pts had prolonged downtime prior to ED presentation, study was sponsored by Zoll Medical Corporation and primary author also has affiliation which may introduce bias

S Rubertsson, et al (2014) – LINC Trial:

Rubertsson S, Lindgren E, Smekal D, et al. *Mechanical Chest Compression and Simultaneous Defibrillation vs Conventional Cardiopulmonary Resuscitation in Out-of-Hospital Cardiac Arrest. The LINC Randomized Trial.* JAMA. 2014;311(1):53-61.

- Multicenter RCT
- 2589 OHCA
- Jan 2008 – Feb 2013
- Primary outcome was to see if mechanical compression with defibrillation vs manual CPR improves 4-hr survival (23.6% vs 23.7%, p >.99) – not statistically significant
- Pts randomized by sealed envelope placed on ambulance
- Manual compressions initially for all until mechanical device could be deployed

- All were shocked at 90 sec in mechanical device group without assessment of rhythm initially. Thereafter, rhythm was checked and shockable rhythms were provided with a shock 90 sec after resuming compressions
- All EMS providers were initially trained in algorithms and retrained q 6 months
- CPC score of 1 or 2 (7.5-8.5% vs 6.4-7.8 % depending on follow up parameters; CI for risk difference all include 0) – not statistically significant
- **Pros:** this is largest RCT to date and most recent published RCT, multicenter trial, good algorithm for randomization which included manual compressions until mechanical device could be deployed, low rate of mechanical device malfunction (<1%), demonstrated non-inferiority to manual compression
- **Indeterminate:** modified ACLS algorithm to include giving shocks to all-comers in the mechanical group and increasing compression intervals to 3 min (delayed defibrillation by protocol design could have been detrimental and earlier defibrillation may have improved outcomes)
- **Cons:** sponsored by Physio-Control leading to possible bias, some pts are too large/small for device to fit appropriately, may be slight increase in AE of mechanical device

P Adams, et al (2014):

Adams P, Schmitz R, Laister D, et al. *Automatic chest compression devices – when do they make sense?* American Journal of Emergency Medicine. 32 (2014):82-85.

- Review study
- Inconsistent indications
- Increased risk of malposition with mechanical device and must be monitored closely
- Mechanical devices consistently demonstrate improved CPR quality in manikin models
- Mechanical compression devices are a very good supplementation to current ERC (European Resuscitation Council) guidelines
- **Pros:** succinct paper that reviews current literature and proposes indication/contraindication on mechanical device usage
- **Con:** Study is not very robust or thorough, no real methods, more of an editorial paper than a true review of literature, doesn't really offer answers to the question that is part of the title

Summary:

- Pros:
 - No fatigue effect
 - Standardized compression depth & rate
 - Allows providers to focus on other tasks

- Current evidence summary indicates mechanical compression devices appear to be at least non-inferior (although further research is needed)
- Indeterminate:
 - ROSC (maybe trend towards benefit)
 - Survival to hospital admission (maybe trend towards benefit)
 - Survival to hospital discharge
 - Survival to hospital discharge with good neurological outcome (only one study and demonstrates trend towards harm; bias may play a role)
 - Adverse Effects (sternal/rib fractures, pneumothorax, hemothorax, internal organ injury, etc...)
- Cons:
 - Time to defibrillation may be longer when using mechanical devices (specifically in one study was 2.1 min longer... could possibly be reduced with additional training)
- Ongoing studies:
 - LUCAT 2013 – Lucas device
 - PARAMEDIC 2013 – Lucas device
 - CIRC 2013 – Zoll device

Conclusion: External Mechanical Compressive devices are a relatively new technology with rapid developments that are demonstrating some promise; however, the current level of evidence does not support routine usage. Further studies are required and several studies are currently underway to answer questions regarding efficacy and determine indications/contraindications for usage.