Taking Mechanical CPR to New Heights: Use of Automated Chest Compression Devices in Helicopter EMS Transport

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NAEMSP 2018 Annual Meeting
January 8-13, 2018
San Diego, CA

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Disclosures

- **I have no disclosures**
  - *Images of any commercial devices are for illustration purposes only*
  - *Inclusion of such images in this presentation does not imply endorsement of any specific device or company*

"In compliance with Federal full-disclosure laws, I'm required to tell you that I'm really not all that sure about some of this stuff."

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...for their assistance in data analysis and presentation development!

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Objective: Describe the potential role and value of Mechanical CPR (mCPR) in Helicopter EMS (HEMS) transport

- How often do patients arrest during transport?
- What do we know about manual compressions during transport?
- Could mCPR be a better method of delivering compressions during transport?
- What can we learn from a HEMS service that is utilizing mCPR?

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Intra-transport cardiac arrest

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Compulsory NAEMSP Annual Conference Lecture Statement:

"If you've seen one EMS system… you've seen one EMS system."

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Feb - Dec 2017

- **2362 transports**
  - age ≥14 y/o (adult)
  - medical & trauma
  - scene & interfacility
- **111 cardiac arrests in-flight; approx. 5% of adult transports**

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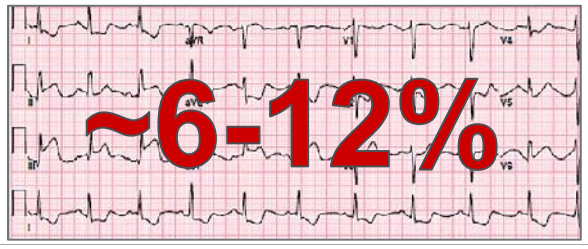
STEMI → Cardiac Arrest before PCI



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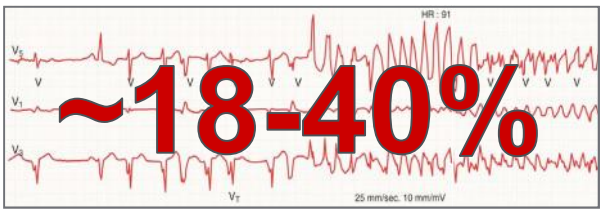
ROSC → Re-Arrest (RA)



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Other cases possibly needing intra-transport chest compressions



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What do we know about providing CPR in transport?

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GOAL: High Quality CPR

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Achieving High Quality CPR…

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REALITY: CPR during ground transport

~20-46%

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REALITY: CPR during HEMS transport

~21-59%

Fist Pump technique | Pec-Press technique | Gumby Arms technique

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CPR during HEMS transport

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Mechanical CPR (mCPR) vs Manual CPR (CPR)

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Mechanical CPR (mCPR)

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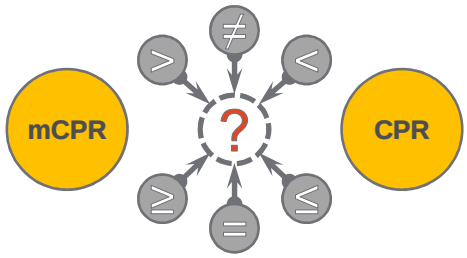
Mechanical vs. Manual CPR



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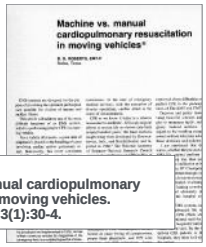
1979



Roberts BG.
Machine vs. Manual cardiopulmonary resuscitation in moving vehicles.
EMT J 1979 Mar;3(1):30-4.

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Quality of mCPR vs. CPR

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Outcomes of mCPR vs. CPR

ASPIRE Trial, 2006
Worse neuro status
Trend to worse survival
Possibly negatively impacted by one study site

LINC Trial, 2013
= quality
= survival
vs High quality CPR

CIRC Trial, 2014
= quality
= survival
vs High quality CPR

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Meta-analysis/Systematic Reviews

Citation	Setting	Summary Statement
Ong, et al *Scand J Trauma Resusc Emerg Med* 2012; 20-39	OHCA	Insufficient evidence to support or refute use of mCPR *Pooled analysis of devices*
Bonnes, et al *An Emerg Med* 2016; 67(3):349-360	OHCA	Cumulative high-quality randomized evidence does not support routine use of mCPR to improve survival or neurologic outcome *Pooled analysis of devices* *Meta-analysis of non-randomized studies demonstrated a benefit in favor of mCPR*
Li, et al *Scand J Trauma Resusc Emerg Med* 2016;24:1-10	OHCA and IHCA	mCPR cannot be recommended as a replacement for CPR, but rather a supplemental treatment in an overall strategy for treating cardiac arrest patients. *Heterogeneity suggests the treatment effect might not be the same for each device compared to CPR:* • Decreased rate of ROSC with LDB device • Non-significant effect on rate of ROSC with piston device • No device-specific treatment effect for survival to hospital admission or discharge • Similar treatment effect for mCPR and CPR for neuro status at discharge • Non-significant increased likelihood of good CPC with any type of device

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Comparing the Research…

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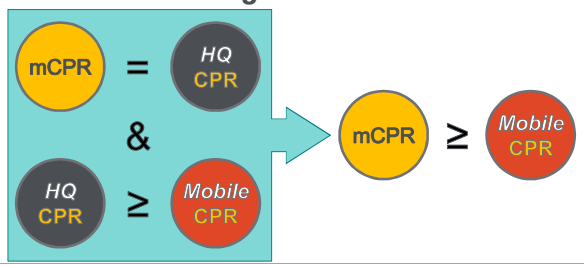
Resuscitation Logic



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Other reasons to implement mCPR?

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Operational Considerations of mCPR for HEMS Programs

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Device Characteristics & Aircraft Stowage

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Patient Selection for HEMS mCPR

SHOCK STEMI ECMO

ROSC RVF DROWNING

TRAUMA HYPOTHERMIA

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Deployment Considerations

- Patient size
- Cabin configuration
- Number of staff needed to apply device
- Stowage location

Apply before you fly!

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Awake Patient Considerations

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Destination Determination Decisions

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Integration with Ground Ambulance and Destination Facilities

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One HEMS program's experience with mCPR

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NMH Air Care

- 9 aircraft (Agusta Grands) stationed at 7 bases
- Medical retrieval and scene flights
- Piston-style mCPR device on all aircraft since 01 Apr 2015
  - Several cases of mCPR in-flight using ground service's device prior to on-board deployment
  - Our entire ground and air service utilizes the same mCPR device (87 units deployed)

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Our mCPR Deployment Criteria

mCPR

- **Indications:**
  - All ROSC patients: Apply preflight
  - Crew discretion: Apply preflight vs in-flight
    - Unstable STEMI (independent of LOC)
    - Severe shock from any cause

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Our mCPR Deployment Criteria

- **Unanticipated in-flight cardiac arrest:**
  1. Initiate manual CPR and ACLS
  2. Assess distance to destination facility
  3. Assess ability to safely execute an unscheduled landing
  4. Balance possible benefit of providing safer/more effective mCPR vs possible harm of delaying arrival at definitive care

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Our mCPR Deployment Criteria

- **Contraindications:**
  - Patient is too large for device
  - Patient is too small for device

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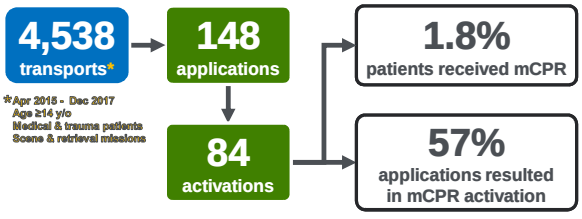
Our Utilization of mCPR



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Twitterverse view of HEMS using mCPR*

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*Results based on Twitter responses from Dec 2017; Map possibly under-represents actual HEMS mCPR use

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Summary

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Next year at NAEMSP: Emerging CPR techniques

K-9 CPR

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Questions?

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Resources:

STEMI → arrest

Jabbari et al. Factors Associated With and Outcomes After Ventricular Fibrillation Before and During Primary Angioplasty in Patients With ST-Segment Elevation Myocardial Infarction. *Am J Cardiol.* 2015 Sept 1;116(5):678-85.

Mehta et al. Incidence of and outcomes associated with ventricular tachycardia or fibrillation in patients undergoing primary percutaneous coronary intervention. *JAMA* 2009;301:1779-1789

Jabbari et al. Incidence and risk factors of ventricular fibrillation before primary angioplasty in patients with first ST-elevation myocardial infarction: a nationwide study in Denmark. *J Amer Heart Assosc*. 2015;4:e001399

ROSC→ RA

Salcido et al. Incidence and outcomes of rearrest following out-of-hospital cardiac arrest. *Resuscitation* 2015 Jan;86:19-24

Salcido et al. Incidence of rearrest after return of spontaneous circulation in out-of-hospital cardiac arrest. *PEC* 2010 Oct-Dec;14(4):413-418

Lerner et al. Rearrest after prehospital resuscitation. *PEC* 2011;15:50-54

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Resources:

CPR quality in Ground transport

Russi et al. A Comparison of Chest Compression Quality Delivered During On-Scene and Ground Transport Cardiopulmonary Resuscitation.*West JEM* 2016 Sept;17(5):634-639

Stone et al. Can correct closed-chest compressions be performed during prehospital transport? *Prehosp Disaster Med* 1995;10(2):121-3

Kim et al. A randomized, controlled comparison of cardiopulmonary resuscitation performed on the floor and on a moving ambulance stretcher. *PEC* 2006;10:68-70

CPR quality in HEMS transport

Putzer et al. LUCAS compared to manual cardiopulmonary resuscitation is more effective during helicopter rescue-a prospective, randomized, cross-over manikin study. *Am J Emerg Med* 2013 Feb;31(2):384-9.

Gasser et al. Mechanical chest compression: an alternative in helicopter emergency medical services? *International Emerg Med* 2015 Sept;10(6):715-20

Rehatschek et al. Mechanical LUCAS resuscitation is effective, reduces physical workload and improves mental performance of helicopter teams. *Minerva Anestesiol* 2016;82:429-37

Havel et al. Quality of closed chest compression in ambulance vehicles, flying helicopters and at the scene. *Resuscitation* 2007;73:264-270

Braunfels et al. A randomized, controlled trial of the efficacy of closed chest compressions in ambulances. *PEC* 1997;1:128-131

Thomas et al. The ability to perform closed chest compressions in helicopters. *Am J Emerg Med* 1994;12(3): 296-8

45

Resources:

mCPR quality

Roberts BG. Machine vs. Manual cardiopulmonary resuscitation in moving vehicles. *EMT J* 1979 Mar;3(1):30-4.

Tranberg et al Quality of cardiopulmonary resuscitation in out-of-hospital cardiac arrest before and after introduction of a mechanical chest compression device, LUCAS-2; a prospective, observational study. *Scand J Trauma Resusc Emerg Med* 2015;23:37

Omori et al. The analysis of efficacy for AutoPulse™ system in flying helicopter. *Resuscitation* 2013;84:1045-50

mCPR outcomes

Hallstrom et al. Manual Chest Compression vs Use of an Automated Chest Compression Device During Resuscitation Following Out-of-Hospital Cardiac Arrest. A Randomized Trial. *JAMA.* 2006;295(22):2620-2628 **[ASPIRE]**

Rubertsson et al. Mechanical Chest Compressions and Simultaneous Defibrillation vs Conventional Cardiopulmonary Resuscitation in Out-of-Hospital Cardiac Arrest The LINC Randomized Trial *JAMA.* 2014;311(1):53-61. **[LINC]**

Wik et al. Manual vs. integrated automatic load-distributing band CPR with equal survival after out of hospital cardiac arrest. The randomized CIRC trial. *Resuscitation* 2014 Jun;85(6):741-8. **[CIRC]**

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Resources:

Meta-analysis/Systematic Reviews

Ong et al. Mechanical CPR devices compared to manual CPR during out-of-hospital cardiac arrest and ambulance transport: a systematic review. *Scand J Trauma Resusc Emerg Med* 2012; 20-39

Bonnes et al. 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. *An Emerg Med* 2016; 67(3):349-360

Li et al. Mechanical versus manual chest compressions for cardiac arrest: a systematic review and meta-analysis. *Scand J Trauma Resusc Emerg Med* 2016 Feb 1;24:1-10

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