MHIF Research Highlights: JANUARY 2019

Congratulations on First Enrollments!

• Dr. Daniel Melby and team – Congratulations on first enrollment in the VISITAG SURPOINT study!

• Dr. David Lin and Christine Majeski – Way to go on your FIRST IN THE WORLD enrollment for the Rhapsody study!

Featured MHIF Studies
Open for Enrollment and Referrals!

ACCUCINCH early feasibility in significant symptomatic MVR and LV remodeling
CONTACT: Sara Olson, 612-863-7601

XIENCE 90 for patients at high risk of bleeding who need coronary stents
CONTACT: Amy McMeans, 612-863-3895

VISITAG SURPOINT tag index-guided ablation for atrial fibrillation
CONTACT: Jacob Cohen, 612-863-6051

Mark Your Calendars

Time to Run… or volunteer!

MHIF is proud to sponsor the Valentine’s 5K with Twin Cities in Motion. Mark your calendar!

Sat., Feb. 9, Lake Nokomis!

Raising Awareness of Valvular Disease!

MHIF is hosting a second annual Mechanics of a Healthy Heart event for patients.

Thurs, Feb. 21, Golden Valley Country Club!

Sharing Great Research…

Dr. Jay Traverse published NHLBI-Sponsored postconditioning study in Circulation Research showing delayed benefit for STEMI patients!

Thanks Dr. Retu Sexana for sharing important updates on women’s heart health for the Twin Cities in Motion Podcast!
Minneapolis Heart Institute Foundation® Cardiovascular Grand Rounds

**Title:** A promising therapy in resuscitation: head up cardiopulmonary resuscitation  
**Speaker:** Johanna C. Moore, MD, MS  
Faculty Physician, Director of Laboratory Research  
Department of Emergency Medicine  
Hennepin Healthcare  
Assistant Professor of Emergency Medicine  
University of Minnesota Medical School  
**Date:** February 4, 2019  
**Time:** 7:00 – 8:00 AM  
**Location:** ANW Education Building, Watson Room

**OBJECTIVES**  
At the completion of this activity, the participants should be able to:  
1. Describe physiology of cardiac arrest and use of circulatory adjuncts during CPR to improve perfusion.  
2. Understand the proposed physiology and mechanisms of actions of Head Up CPR.  
3. Explain potential clinical benefits of Head Up CPR.

**ACCREDITATION**  
*Physician* - Allina Health is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians. Allina Health designates this live activity for a maximum of 1.0 **AMA PRA Category 1 Credit(s)**™. Physicians should only claim credit commensurate with the extent of their participation in the activity.  

*Nurse* - This activity has been designed to meet the Minnesota Board of Nursing continuing education requirements for 1.0 hours of credit. However, the nurse is responsible for determining whether this activity meets the requirements for acceptable continuing education.

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Allina Health, Learning & Development intends to provide balance, independence, objectivity and scientific rigor in all of its sponsored educational activities. All speakers and planning committee members participating in sponsored activities and their spouse/partner are required to disclose to the activity audience any real or apparent conflict(s) of interest related to the content of this conference.  

The **ACCME defines a commercial interest** as “any entity” producing, marketing, re-selling, or distributing health care goods or services consumed by, or used on, patients. The ACCME does not consider providers of clinical service directly to patients to be commercial interests - unless the provider of clinical service is owned, or controlled by, an ACCME-defined commercial interest.
Moderator(s)/Speaker(s)

Dr. Johanna Moore has disclosed that she DOES NOT have any real or apparent conflicts with any commercial interest as it relates to presenting the content in this activity/course.

Planning Committee

Dr. Alex Campbell, Jake Cohen, Jane Fox, Dr. Mario Gössl, Dr. Kevin Harris, Dr. Kasia Hryniewicz, Rebecca Lindberg, Amy McMeans, Dr. Michael Miedema, Dr. JoEllyn Moore, Pamela Morley, Dr. Scott Sharkey, and Jolene Bell Makowesky have disclosed that they DO NOT have any real or apparent conflicts with any commercial interest as it relates to the planning of this activity/course. Dr. David Hurrell has disclosed the following relationship - Boston Scientific: Chair, Clinical Events Committee.

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We would like to thank the following company for exhibiting at our activity.

Amgen  Zoll LifeVest

Accreditation of this educational activity by Allina Health does not imply endorsement by Allina Learning & Development of any commercial products displayed in conjunction with an activity.

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PLEASE SAVE YOUR SERIES FLIER

When you request a transcript this serves as your personal tracking of activities attended. Most professional healthcare licensing/certification boards will not accept a Learning Management System (LMS) transcript as proof of credit; there are too many LMS’s across the country and their validity/reliability are always in question.

If audited by a licensing board or submitting for license renewal or certification renewal, boards will ask you not the entity providing the education for specific information on each activity you are using for credit. You will need to demonstrate that you attended the activity with a copy of your certificate/evidence of attendance, a brochure/flier and/or the conference handout.

Each attendee at an activity is responsible for determining whether an activity meets their requirements for acceptable continuing education and should only claim those credits that he/she actually spent in the activity.

Maintaining these details are the responsibility of the individual.

PLEASE SAVE A COPY OF THIS FLIER AS YOUR CERTIFICATE OF ATTENDANCE.

Signature: __________________________________________________________________________

My signature verifies that I have attended the above stated number of hours of the CME activity.

Allina Health - Learning & Development - 2925 Chicago Ave - MR 10701 - Minneapolis MN 55407
Head Up CPR
February 4, 2019

Johanna Moore MD, MSc
Department of Emergency Medicine
Hennepin Healthcare

Assistant Professor
University of Minnesota Medical School

Financial Disclosures

- No COI to disclose
- Co-PI on NIH NHLBI SBIR grant
This is your brain...on CPR. What do you want?

Cerebral Perfusion Pressure = Mean Arterial Pressure - Intracranial Pressure
ACD: Active Compression Decompression
ITD: Impedance Threshold Device

Head Up CPR: Take Home Points

- Animal studies have shown that Head Up CPR as compared to flat CPR:
  - Increases cerebral perfusion pressure
  - Increases cerebral blood flow
  - Increases coronary perfusion pressure
  - Decreases Intracranial Pressure
- Human cadaver studies have shown that Head Up CPR as compared to flat CPR:
  - Increases cerebral perfusion pressure and decreases intracranial pressure
- Head Up CPR used as a part of new bundles of care has resulted in increased hospital to admission rates

Why do we need to improve CPR?

<table>
<thead>
<tr>
<th></th>
<th>Hennepin EMS (n = 357)</th>
<th>Minnesota (n = 2,216)</th>
<th>National (n = 76,215)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Survival (all rhythms)</td>
<td>14.0% (50)</td>
<td>12.0% (267)</td>
<td>10.4% (7949)</td>
</tr>
<tr>
<td>Overall Survival with good brain function</td>
<td>9.8% (35)</td>
<td>9.7% (216)</td>
<td>8.4% (6392)</td>
</tr>
<tr>
<td>Utstein Bystander (shockable rhythm, witnessed, bystander CPR)</td>
<td>46.9% (32)</td>
<td>40.8% (184)</td>
<td>36.5% (4935)</td>
</tr>
</tbody>
</table>
Time Up After 23-25ish Minutes?


There Is No Silver Bullet

- There is not a single fix to improve outcomes
- We must build upon the chain of survival
  - Try to ensure patients get as many elements as possible
  - Build new promising therapies into the chain of survival
- Enhancing perfusion during CPR is optimal for all brains and hearts, regardless of etiology of arrest
Inspiration

Seoul, South Korea

What Position is best?

Head Down

Head Up

Flat
Head Up CPR: How Does It Work?

- Similar to the concept of elevating the head of a patient with a neurosurgical emergency
- Increases venous drainage from head, venous sinuses, and cervical paravertebral plexus
- Decreases “concussion with every compression” by mitigating pressure transduced up the vasculature to the head
- Ultimately improves cerebral blood flow, perfusion pressures
- Improves cardiac flow? Reduces pulmonary vascular resistance? Improves neuro outcomes?

Head Up CPR-First Study 2014

- 14 pigs were placed on a tilt table, underwent LUCAS+ITD CPR
- 5 min supine, 5 min Head Up, 5 min Head Down after 6 min of ventricular fibrillation
- An additional 8 pigs were measured at different angles of CPR
- Brain blood flow was measured in 8 pigs

Debaty et al., Resuscitation, 2015.

Change of Position: Head Down

Debaty et al., Resuscitation, 2015.
Change of Position: Head Up

Debaty et al., Resuscitation, 2015.

Head Up CPR: First Study

- Cerebral brain blood flow was 50% higher (0.19 ± 0.04 ml/min/g/tissue at 0° vs 0.27 ± 0.04 at 30° Head Up)

- Cerebral perfusion pressure was higher (19 ± 3 mmHg at 0° vs 35 ± 3 at 30° Head Up) (p < 0.001)

- Coronary perfusion pressure was higher (19 ± 2 mmHg at 0° vs 30 ± 3 at 30° Head Up) (p < 0.001)
Head Up CPR: Second Study

- Different body position
- Different CPR methods: ACD+ITD and standard
- Longer ventricular fibrillation time (8 min)
- 2 minutes flat, or “priming”
- Longer CPR time (22 min total)


Head Up CPR: Third Study

- Sought to replicate study 2, with brain blood flow Brain blood flow doubled at 15 min:

ACD+ITD Flat at 0.21 ± 0.04 mg/mL/g tissue
ACD+ITD Head Up 0.42 ± 0.05 mg/mL/g tissue (p = 0.01)

**0.19 ± 0.04 flat vs. 0.27 ± 0.04 mg/mL/g tissue HUP with LUCAS+ITD at 5 minutes**
Is There an Optimal Angle?

• VF left untreated for 8 minutes
• Animals were randomized to one of 6 combinations for 5 minute CPR intervals:

  20°, 30°, 40°  20°, 40°, 30°
  30°, 20°, 40°  30°, 40°, 20°
  40°, 20°, 30°  40°, 30°, 20°

• No difference in Cerebral Perfusion Pressure ($p = 0.52$) in 13 pigs:
  20°, 36 ± 19
  30°, 42 ± 21
  40°, 44 ± 27

Is There an Optimal Angle?

• Must balance ICP and Aortic Pressure 30 degrees of elevation maximizes coronary and cerebral perfusion with LUCAS+ITD
• Probably between 30° and 40° but the absolute height of the heart and brain and rate of rise is more important

CerPP was higher if $40^\circ$ HUP was performed during the last 5 minutes of the resuscitation ($81 \text{ mmHg} \pm 16$), versus $20^\circ$ HUP and $30^\circ$ HUP combined ($41 \text{ mmHg} \pm 19$, $p = 0.007$)

Moore et al, AHA-ReSS, 2018

**Sequence Study**

- 13 animals studied: 7 with $20^\circ$, $30^\circ$, $40^\circ$ sequence and 6 with $40^\circ$, $30^\circ$, $20^\circ$
- After 15 minutes of CPR, CerPP were higher with the $20^\circ$, $30^\circ$, $40^\circ$ sequence: $54 \pm 21$ mmHg versus $26 \pm 18$ mmHg ($p = 0.03$)

<table>
<thead>
<tr>
<th></th>
<th>Cerebral Perfusion Pressure, mmHg ± SD</th>
<th>Coronary Perfusion Pressure, mmHg ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>$20^\circ$, $30^\circ$, $40^\circ$</td>
<td>$54 \pm 21$</td>
<td>$45 \pm 20$</td>
</tr>
<tr>
<td>$40^\circ$, $30^\circ$, $20^\circ$</td>
<td>$26 \pm 18^*$</td>
<td>$25 \pm 16$</td>
</tr>
</tbody>
</table>

* $p = 0.03$

Moore et al, AHA-ReSS, 2018
Sequence Study

Cerebral Perfusion Pressure

Coronary Perfusion Pressure

Mean Aortic Pressure

Mean Intracranial Pressure

Moore et al, AHA-ReSS, 2018
You’re Doing It Wrong…

• All animal studies have shown that Head Up CPR is reliant on technology that augments perfusion during CPR such as LUCAS+ITD or ACD+ITD

• Standard CPR does not provide good enough baseline perfusion to harness the effect of HUP CPR

• It is hard to pump blood uphill
Human Cadaver Head Up Studies

- Sought to replicate Head Up physiology in humans
- Studied 9 recently deceased human cadavers who had donated their bodies to science
- Bodies were never frozen. Airway, Vascular, Intracranial Access
- 2 minute epochs of standard, ACD+ITD CPR, ACD+ITD Head Up CPR

<table>
<thead>
<tr>
<th></th>
<th>S-CPR</th>
<th>ACD+ITD CPR</th>
<th>ACD+ITD HUP CPR</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITP</td>
<td>-0.1±1</td>
<td>-5.0±2 **</td>
<td>-5.7±2</td>
</tr>
<tr>
<td>MAP</td>
<td>7.8±4</td>
<td>5.2±3*</td>
<td>5±5</td>
</tr>
<tr>
<td>RA</td>
<td>9.0±2</td>
<td>8.7±3</td>
<td>9.9±5</td>
</tr>
<tr>
<td>ICP</td>
<td>0.8±2</td>
<td>0.7±3</td>
<td>-8.1±6**</td>
</tr>
<tr>
<td>CerPP</td>
<td>3.5±4</td>
<td>1.3±4.3*</td>
<td>11.3±5**</td>
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</table>

*** p≤0.001; ** p<0.01; * p<0.05 vs the previous intervention

Human Cadaver Tracing


Palm Beach County Florida
Head Up CPR Experience (2014-2016)
Paul E. Pepe, MD, MPH, Kenneth A. Scheppke, MD, Peter M. Antevy, MD

Protocol Changes in 2015
1) Ensure proper use of mechanical CPR
2) Apply O₂ but defer ventilation 6 mins;
3) Apply impedance threshold device;
4) Automated CPR
5) Raise the backboard 30° (head/torso up position).

Confirming the Clinical Safety and Feasibility of a Bundled Methodology to Improve Cardiopulmonary Resuscitation Involving a Head-Up/Torso-Up Chest Compression Technique
Paul E. Pepe, MD, MPH, MCCM, MACP, FAEMS; Kenneth A. Scheppke, MD; Peter M. Antevy, MD; Remie F. Crowe, PhD, NREMT; Daniel Millstone, EMT-P; Charles Gayle, EMT-P; Craig Prusansky, EMT-P; Sebastian Garey, EMT-P; Richard Ellis, EMT-P; Raymond L. Fowler, MD, FACEP, FAEMS; Johanna C. Moore, MD, MPH

In Press
Critical Care Medical 2018
Overall Outcomes – Survival to Hospital Admission

<table>
<thead>
<tr>
<th>Resuscitation Rates</th>
<th>Before</th>
<th>After</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients</td>
<td>17.9%</td>
<td>34.2%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>VF/VT</td>
<td>23.0%</td>
<td>44.4%</td>
<td>=0.001</td>
</tr>
<tr>
<td>Non-VF/VT</td>
<td>13.6%</td>
<td>30.9%</td>
<td>&lt;0.001</td>
</tr>
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</table>


2100 Cases from 2014-2016
Palm Beach County Outcomes: Survival to Hospital Admission

*Figure 4.* The raw number of patients resuscitated by emergency medical services teams who were successfully delivered to the emergency department alive with sustained circulation for the calendar years 2014, 2015 (the year of transition with inclusion of head-up cardiopulmonary resuscitation), and 2016, respectively.

Outcome improved across all subgroups while response intervals, indications for initiating CPR, and bystander CPR rates were unchanged

Wedge and towel

Mechanical lift with sniffing position
Body and LUCAS Slip Off
The "Do’s and Don’ts" of Head Up CPR

**Do’s**

1. Use circulatory adjuncts during CPR (ITD alone + standard CPR, automated CPR+ ITD, ACD+ITD)
2. "Prime" the circuit before elevation (90-120 sec)
3. Consider elevating the head and chest/shoulders only during CPR

**Don’ts**

1. Perform Head Up CPR with standard CPR alone
2. Raise the head of the patient immediately while in arrest
3. Avoid elevating the whole body over prolonged CPR effort
4. Elevate at a high angle, then come down, there is a sequence effect


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The Bundle of Care-Head Up CPR

<table>
<thead>
<tr>
<th>Electrical</th>
<th>Circulatory</th>
<th>Metabolic</th>
<th>Refractory Arrest</th>
<th>Post ROSC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 4 minutes</td>
<td>4 to 10 (20?) minutes</td>
<td>10 (20?) to 60 minutes?</td>
<td>&gt;60 min, await ROSC post cath</td>
<td>Therapeutic Hypothermia</td>
</tr>
<tr>
<td>Immediate High Quality CPR</td>
<td>Head Up CPR</td>
<td>Epinephrine?</td>
<td>Cardiac Catheterization</td>
<td>Maintain MAP (65? 80?) via pressors, fluids, active IPR therapy</td>
</tr>
<tr>
<td>Defibrillation</td>
<td></td>
<td>Anti-arrhythmics</td>
<td>Head Up CPR</td>
<td>Head Up Position?</td>
</tr>
</tbody>
</table>

MHIF CV Grand Rounds – Feb 4, 2019
Summary

1. Head Up CPR improves cerebral perfusion, and to a lesser degree, cardiac perfusion.
2. Findings of animal studies have been replicated in cadaver studies
3. Head Up CPR is used as parts of new bundles of care in a few sites throughout the country, with improved outcomes
4. Head Up CPR must be performed with circulatory adjuncts
5. Head Up CPR is a promising therapy to improve neurologic outcome after cardiac arrest
6. There is no silver bullet for cardiac arrest—many things must be performed correctly in the chain of survival for a good neurologic outcome!

References

References 2


- Moore JC, Segal N, Debaty G, Lurie KG. The “Do's and Don'ts” of Head Up CPR: Lessons Learned from the Animal Laboratory.” Resuscitation. August 2018; 129: e6‐e7

- Moore JC, Salverda B, Lick M, Rojas-Salvador C, Debaty G, Segal N, Lurie KG. Controlled progressive elevation maximizes cerebral perfusion pressure during head up CPR in a swine model of cardiac arrest. Accepted for oral presentation at the AHA Resuscitation Science Symposium, November 2018, Chicago, IL.

References 3


- Rojas-Salvador C, Moore JC, Salverda B, Debaty G, Lick M, Lurie KG. Controlled fast head and thorax elevation improves cerebral perfusion pressure during active compression and decompression cardiopulmonary resuscitation with an impedance threshold device in a porcine model of cardiac arrest. Accepted for poster presentation at the NAEMSP Annual Meeting, 2019, Austin TX.