A COMPARISON OF 3 METHODS OF PERFORMING EXTERNAL CHEST COMPRESSIONS DURING MICROGRAVITY SIMULATION

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Disclosure Information

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I have no financial relationships to disclose.

I will not discuss off-label use and/or investigational use in my presentation.
OVERVIEW

- INTRODUCTION
- OBJECTIVES
- METHODS
- RESULTS
- CONCLUSION
INTRODUCTION

- Cardiac arrest is the acute stop of blood circulation due to failure of effective heart contraction
- Cardio Pulmonary Resuscitation (CPR):
  - External Chest Compressions (ECCs) + Ventilation
- Likelihood of cardiac arrest is 1% per year for astronauts on a brief to moderate length mission (Johnston et al, 2000)
  - Need for Basic Life Support (BLS)
  - Terrestrial BLS guidelines are advocated for microG
2010 ILCOR regulations on CPR state optimal ECC rate is approximately **100 cpm** and optimal depth is minimum 50mm.

- Previously 40-50mm
- ECCs first then ventilation
  - 30:2
OBJECTIVES

- Simulate microgravity to compare 3 methods of performing ECCs

1. Evetts-Russomano [ER]
2. Reverse Bear Hug [RBH]
3. Hand Stand [HS]

AIM

To determine which of the three proposed methods of carrying out immediate, single rescuer ECCs would be most successful in a microgravity environment.
METHODS

- Volunteers
  - n=23 M

- Protocol
  - 90 minutes
  - Randomized RBH / HS / ER order selection
  - 4 ECC sets and 6s ventilation period

- Materials
  - Borg Scale (6-20)
  - LED display for ECC feedback
  - Nonin Onyx Pulse Oximeter
  - Standard Rescusi Anne Skill Reporter
  - CPR mannequin modified
  - Data Q acquisition device

<table>
<thead>
<tr>
<th>BASELINE</th>
<th>+1Gz</th>
<th>REST</th>
<th>1</th>
<th>REST</th>
<th>2</th>
<th>REST</th>
<th>3</th>
</tr>
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<tbody>
<tr>
<td>5 min</td>
<td>1.5 min</td>
<td>10 min</td>
<td>1.5 min</td>
<td>10 min</td>
<td>1.5 min</td>
<td>10 min</td>
<td>1.5 min</td>
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METHODS (cont.)

Evetts-Russomano [ER]

Reverse Bear Hug [RBH]

Hand Stand [HS]
RESULTS

- **Subject Data (n=23 M)**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Male (n=23)</th>
<th>Range</th>
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<tbody>
<tr>
<td>**Mean (±SD)</td>
<td></td>
<td></td>
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<tr>
<td><strong>Age (yr)</strong></td>
<td>22 (±3.1)</td>
<td>18-27</td>
</tr>
<tr>
<td>**Weight (kg)</td>
<td>75.6 (±12.5)</td>
<td>55-105</td>
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<tr>
<td>**Height (cm)</td>
<td>180.8 (±7.1)</td>
<td>1.67-1.96</td>
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<tr>
<td>**BMI (kg/m²)</td>
<td>23.01 (±3.04)</td>
<td>17.8-27.3</td>
</tr>
</tbody>
</table>

- **ECC Depth Terminology**
RESULTS [2]: ECC Rate and ECC Range of Depth

Figure 1. Total Mean Male ECC Rate for all four ECC sets at +1Gz, ER, HS and RBH positions (A) and Total Mean ECC Range of Depth for all four ECC sets at +1Gz, ER, HS and RBH positions (B). The dashed line depicts 2010 effective limits for ECC rate (A) and depth (B). n=23. Significant from +1Gz: **p<0.001, ***p<0.0001.
Figure 2. Male mean ±SD % HR change from resting HR post completion of 4 ECC sets at +1Gz, ER, HS and RBH positions. n=23. Average baseline HR was 82 ± 12 bpm.

*Significant from +1Gz, p<0.05. †Significant from HS, p<0.05.
RESULTS [4]: Effect on Rescuer

Figure 3. Male mean Rate of Perceived Exertion (RPE) post completion of 4 ECC sets at +1Gz, ER, HS and RBH positions. n=23. *Significant from +1Gz; +Significant from RBH; δSignificant from ER; γSignificant from HS, p<0.001.
CONCLUSION

- RBH seems to be the worst technique by far in terms of rate, RoD and fatigueability. Was unable to achieve anything near required RoD even in the first minute of ECCs.

- ER appears promising with adequate ECC rate. RoD was not adequate despite maximal ECC depth providing some clinical benefit, important to account for true ECC depth.

- HS appeared overall most effective yet the lower compression rate may result in poorer survival outcomes. This position is rescuer-height and capsule-size dependent.
LIMITATIONS AND FUTURE DIRECTIONS

- MicroG simulation
- Resusci Anne mannequin designed for $+1G_z$
- Trolley System: support + friction
- Not representative of astronaut population
- No females
- Increased length of ECC administration
THANK YOU FOR YOUR ATTENTION

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Simulated microG via Body Suspension Device (For ER and RBH positions)