**WORKSHEET for Evidence-Based Review of Science for Emergency Cardiac Care**

**Worksheet author(s)**

| Lindsay Mildenhall MBChB FRACP | Date Submitted for review: 24 September 2009 |

**Clinical question.**

In babies (P) receiving chest compressions does the two thumb (I) versus two finger (C) method of administration improve outcome (O)?

Is this question addressing an intervention/therapy, prognosis or diagnosis?  
Intervention

State if this is a proposed new topic or revision of existing worksheet:  
Revision

**Conflict of interest specific to this question**

Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet?  
No

**Search strategy (including electronic databases searched).**

- **Cochrane Library:** cardiotopulmonary resuscitation heart massage as MESH (headings), two finger or two thumb and newborn as “search all text” (5 hits)
- **Cochrane Library:** cardiotopulmonary resuscitation and two finger or two thumb in “Record title” (2 hits)
- **Ovid (Medline):** cardiopulmonary resuscitation or heart massage (MESH Headings) or chest compression as “key word”. Limits to English language, 1950-2009 and newborn infant (birth-1 month) and thumb or finger; (9 hits)
- **PubMed:** Cardiopulmonary resuscitation or heart massage MESH Headings. Chest compression(s) as key words Limits: 1950-2009, English language, Newborn to 1 month, Animals/Humans (5 hits)
- **AHA Endnote Master Library:** 24 March 08 finger and thumb (8 hits)
- **Google Scholar:** “two finger, two thumb, heart massage”

Pertinent articles were cross referenced with “find related article” or “find citing article” searches

All searches completed 22nd September 2009

**State inclusion and exclusion criteria**

**Inclusions:**  
Human, animal or mechanical (manikin) subjects

**Exclusions:**  
Abstract-only articles

Subjects older than 1 month of age (studies considered if a portion of the subjects enrolled were less than 1 month of age)

Articles in languages other than English

**Number of articles/sources meeting criteria for further review:**

13 studies met criteria for further review. Of these 3 were LOE 4 and 10 LOE 5.
# Summary of evidence

## Evidence Supporting Clinical Question

<table>
<thead>
<tr>
<th>Good</th>
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<td>David 1988E&lt;br&gt;Todres 1975E</td>
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**Level of evidence**

A = Return of spontaneous circulation  
B = Survival of event  
C = Survival to hospital discharge  
D = Intact neurological survival  
E = Other endpoint

*Italics = Animal studies*
### Evidence Neutral to Clinical question

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**Level of evidence**

A = Return of spontaneous circulation  
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E = Other endpoint  
B = Survival of event  
D = Intact neurological survival  
**Italics** = Animal studies

### Evidence Opposing Clinical Question

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**Level of evidence**

A = Return of spontaneous circulation  
C = Survival to hospital discharge  
E = Other endpoint  
B = Survival of event  
D = Intact neurological survival  
**Italics** = Animal studies
Discussion: The literature consists of animal and manikin trials using randomized crossover designs plus a combination of cadaver studies and case series in humans. The two thumb method with the hands encircling the chest consistently produced higher blood pressure and coronary perfusion pressure when compared to the two finger technique in swine models (Houri 1997; Menegazzi 1993). Identical findings have been secured from manikin studies with, in addition, evidence that the two thumb technique provides more stable measures over a prolonged period (5 or 10 minutes) of resuscitation (Dorfsman 2000; Haque 2008, Udassi 2009). One study using a variety of medical personnel found however no difference in the quality of chest compressions between methods when given over a brief period of CPR (2 minutes) with the majority performing poorly with either method. One positive point in favour of the two thumb technique from this study was the proportion of compressions deemed too shallow was significantly less when compared with the two finger technique (Whitelaw 2000). Case histories in humans have demonstrated higher blood pressure generated by the two thumb technique when alternated with the two finger technique in infants undergoing CPR with central arterial lines in situ (David 1988; Todres 1975). A study using cadavers found the two thumb method of CPR required less force to generate the same blood pressure as the two finger method (Thaler 1963).

While the evidence in support of the two thumb technique is consistent, the studies are few in number. Not all performed chest compressions in combination with ventilation breaths and in none was the quality of the ventilation analysed. All use blood pressure generation or various analyses of compression quality as their primary endpoints. The not unreasonable assumption is that these measures imply more efficient CPR and a better outcome for the patient however that assumption has never been tested. The issue of single verses multiple rescuers is also of interest. The two thumb technique is described as less draining on a rescuer and able to deliver compressions of a higher quality over a longer time period than the two finger method. Logic would suggest that this is the best method for single and multiple rescuers but practical concerns have been raised in the single rescuer of using the two thumb technique and adequately managing the airway. The two finger technique therefore maybe more appropriate in some circumstances of single rescue.

Confirmation of the anatomical heart position was examined by another study (Phillips 1986), which included babies from 27 weeks preterm to 13 months, confirming the centre of the heart to be over the lower third of the sternum in 87% of the 55 babies examined. The optimal position for chest compressions in infants was further assessed (Orlowski 1986). Four examination techniques each demonstrated that the heart lies over the lower third of the sternum in infants and compressions over that point are more effective than mid sternal compressions.

Optimal depth of chest compression using the two thumb technique was investigated (Maher 2009) in a retrospective case series of 6 complex congenital heart disease patients during pulseless cardiac arrest post operation. Compressing the chest one half verses one third the anterior posterior diameter produced higher systolic, mean blood pressure and higher pulse pressure. Deeper compressions however did not alter diastolic blood pressure suggesting no improvement in coronary artery blood flow. A recent study using CT scan data to obtain internal chest measurements in the infant population (<3 months-1 year; Braga 2009) has suggested that with a one half anterior posterior (AP) external diameter chest compression the majority of infants in the younger range of this age group would have virtually no residual internal chest depth left raising the potential for damage to underlying structures. This prospect was eliminated when compressions were restricted to one third the AP diameter.

Acknowledgements:
Ms Joanne Martin, Librarian, Counties Manukau DHB
Citation List


Worksheet author comments:

1. LOE 5 (Case series not directly related to the specific patient/population)/QOE Poor/ Neutral
Focused on the 3 months – 8 years population but included 20 subjects < 3 months in sample. No hemodynamic information to support conclusions. All children with co-morbidities warranting CT scan. Potential compressibility of soft tissue structures could not be factored in. Concern that chest compressions leaving < 10 millimetres of residual internal chest depth could potentially damage internal structures.

2. Magnitude of observed effect:

Data extrapolated from Figure in article for 20 babies less than 3 months of age. With compressions one third the AP diameter, all subjects had residual internal chest depth greater than 10 millimetres (median approximately 17 mm; range approximately 14-25 millimetres). With compressions one half the AP diameter all subjects had residual internal chest depth less than 10 millimetres (median approximately 2 millimetres range approximately -1-8 millimetres).

3. No industry funding


Worksheet author comments:

1. LOE 4 (Case series) / QOE Poor / Supports

2. Magnitude of observed effect:

Case 1: Two thumb (TT) Mean arterial pressure (MAP) 30 mmHg, Pulse Pressure 16 mmHg; Two finger (TF) Mean arterial pressure 14 mmHg, Pulse Pressure 6 mmHg

Case 2: TT MAP = 32 mmHg; TF = 18 mmHg

3. No industry funding


Worksheet author comments:
1. LOE 5 (manikin) / QOE Fair (Prospective, randomised, crossover design, blinded to pressures created) / Supports

2. Magnitude of effect: Systolic BP estimated marginal mean differences between TT (68.9) and TF (44.8) of 24.1mmHg in favour of TT; diastolic BP mean difference of 5.1 mmHg in favour of TT; mean arterial pressure mean difference of 12.0 mmHg in favour of TT and pulse pressure of 19.1mmHg in favour of TT method. 90% of rescuers preferred the TT method although the pattern of decreasing pressures over time was the same for both methods.

3. No industry funding


Worksheet author comments:

1. LOE 5 (manikin) / QOE Poor / Supports
Study comparing 15:2 and 30:2 ratios but including infant manikins with subgroups using two thumb verses two finger chest compressions. Subjects were health care personnel trained in resuscitation but no extra instruction given during participation in this trial. Ventilations were simulated. Statistical analysis was structured to analyse the difference between ratios and not the techniques. Trend toward superior performance in the two thumb technique compared with two finger in most parameters measured especially compression depth, compression peak pressure and compression mean pressure.

2. Magnitude of effect
Compression depth(mm) vs ratio over 5 minutes mean +/- standard deviation

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<tr>
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<th>30:2</th>
<th>15:2</th>
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<tbody>
<tr>
<td>Infant two finger</td>
<td>8.7 +/- 1.9</td>
<td>9.5 +/- 2.6</td>
</tr>
<tr>
<td>Infant two thumb</td>
<td>13.8 +/- 2.5</td>
<td>14.4 +/- 2.8</td>
</tr>
</tbody>
</table>

3. No industry funding


Worksheet author comments:

1. LOE 5 (animal model) / Fair (Randomised crossover design) / Supports

2. Animal model with resuscitation after up to 10 minutes of asphyxia. When feedback removed the TT pressures generated were higher than when feedback provided

Magnitude of effect:
TT with feedback | TT without feedback | TF with feedback | TF without feedback
---|---|---|---
**Systolic BP** 20.7 (6.37)* | 22.7 (7.23)* | 16.6 (5.38) | 14.5 (4.95)  
**Diastolic BP** 3.5 (2.09) | 3.4 (1.82) | 3.5 (1.60) | 3.4 (1.16)  
**Sternal compression force (psi)** 22.9 (6.05) | 20.3 (9.10) | 17.0 (5.71) | 14.6 (7.34)  

*p < 0.05 when compared with TF; means (SD); BP = mmHg

3. No industry funding


**Worksheet author comments:**

1. LOE 4 (case series) / QOE Poor / Neutral  
All patients arrested post operation with an arterial line in situ. All were concurrently hand ventilated via an endotracheal tube. Depth of chest compressions not quantitatively measured, only qualitatively estimated. Two thumb, fingers around chest only method of chest compression used. All 6 cases had extremely complex congenital heart disease. Median age 1.0 month (range 2 weeks – 7.3 months); median weight 4.6kg (range 3.1 – 6.1kg). If one assumes coronary artery flow is diastolic blood pressure dependent then there is no apparent advantage demonstrated for one third verses one half anterior-posterior chest compression during CPR.

2. Magnitude of effect:

<table>
<thead>
<tr>
<th></th>
<th>Systolic BP</th>
<th>Diastolic BP</th>
<th>Mean arterial pressure</th>
<th>Pulse pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/3 AP diameter</td>
<td>51.6 +/- 9.8</td>
<td>30.6 +/- 12.9</td>
<td>37.5 +/- 8.3</td>
<td>21.0 +/- 5.3</td>
</tr>
<tr>
<td>1/2 AP diameter</td>
<td>83.4 +/- 12.1*</td>
<td>30.5 +/- 13.3</td>
<td>48.0 +/- 10.8*</td>
<td>52.9 +/- 14.5*</td>
</tr>
</tbody>
</table>

*p <0.001 compared with 1/3 AP diameter  
Values are means +/- SD mmHg

3. No industry funding


**Worksheet author comments:**

1. LOE 5 (animal model) / QOE Fair (Crossover design) / Supports

2. Magnitude of effect:
<table>
<thead>
<tr>
<th></th>
<th>Systolic BP</th>
<th>Diastolic BP</th>
<th>Mean arterial pressure</th>
<th>Coronary perfusion pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two thumb</td>
<td>59.4 +/- 30*</td>
<td>21.8 +/- 15*</td>
<td>34.2 +/- 19*</td>
<td>15.1 +/- 14*</td>
</tr>
<tr>
<td>Two finger</td>
<td>41.6 +/- 16</td>
<td>18.5 +/- 12</td>
<td>26.1 +/- 13</td>
<td>12.2 +/- 11</td>
</tr>
</tbody>
</table>

* p <0.001 compared with two finger
Values are means +/- SD mmHg

3. No industry funding


**Worksheet author comments:**

1. LOE 5 (observational study + cases series) / QOE Poor / Support

2. Difficult to tease out the number of neonates in each of the 4 subsections of this study however no apparent difference in heart position with age. Study supports the use of the lower third of the sternum for compressions. Study doesn’t specify the technique (i.e. two-thumb vs two finger) in the PICU group receiving chest compressions other than stating external cardiac compressions were performed by AHA standards as of 1980.

3. No industry funding


In a radiographic study of 55 infants with an age-range of 27 weeks' gestation to 13 months post-term, the centre of the heart was positioned under the lower third of the sternum in 48 cases. In 4 infants the position was slightly more cephalad, but still below the lower half of the sternum. In 3 infants, the position was below the xiphisternal junction. Present guidelines for infant resuscitation should be revised in view of these findings.

**Worksheet author comments:**

1. LOE 5 (observational study + cases series) / QOE Poor / Support

2. Magnitude of effect.

Mean position of Heart Centre as a % along the sternum. Lower third of sternum defined as 0-33%

<table>
<thead>
<tr>
<th></th>
<th>Mean position of heart centre as % of distance from Xiphisternum (0%) to suprasternal notch (100%)</th>
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<tbody>
<tr>
<td>Total</td>
<td>17.46</td>
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<tr>
<td>Preterm</td>
<td>21.61</td>
</tr>
<tr>
<td>Term</td>
<td>13.14</td>
</tr>
</tbody>
</table>
3. No industry funding


**Worksheet author comments:**

1. LOE 5 (Cadavers) / QOE Poor / Supports
2. Anatomical photo erroneously showing the heart higher in the chest than occurs in living patients.
3. No industry funding


**Worksheet author comments:**

1. LOE 4 (Case report) / Poor (No controls) / Supports
2. No industry funding


**Worksheet author comments:**

1. LOE 5 / QOE Fair (randomised observational) / Supports
2. Magnitude of effect:

<table>
<thead>
<tr>
<th>Compression variables</th>
<th>Two Thumb</th>
<th>Two finger</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression depth (mm)</td>
<td>13.8 +/- 2.5</td>
<td>8.7 +/- 8.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Peak compression pressure(mmHg)</td>
<td>154 +/- 54</td>
<td>85 +/- 23</td>
<td>&lt;0.001</td>
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<tr>
<td>Mean compression pressure(mmHg)</td>
<td>54 +/- 20</td>
<td>28 +/- 12</td>
<td>&lt;0.001</td>
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3. No industry funding

**Worksheet authors comments:**

1. LOE 5 (manikin) / QOE Fair (randomised crossover) / Neutral

2. Personnel of varying training levels failed to maintain good compression skills. 71% failed to give adequate compressions using both methods. 19% performed adequate compressions using the TT method, 18% using the TF method (no significant difference). Reviewing the too shallow compressions, this was more likely with the TF technique when compared with the TT technique ($p < 0.0005$). Practitioners should be taught the method best suited to their working environment e.g. firemen use the TF method because they are often doing this procedure when carrying an infant out of a building to an ambulance and need the other hand to support the infants head and back.

3. No industry funding