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

**Worksheet author(s)**

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<th>Myra H. Wyckoff, MD</th>
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**Date Submitted for review:**

| 12-15-09 |

## Clinical question.

For newborns receiving chest compressions (P) does the use of a two thumb technique (I) as opposed to a two finger technique (C) 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:** New Topic for NRP group but has been examined by Peds Group

### Conflict of interest specific to this question

Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet? Intellectual conflict: Currently funded to study ergonomics of this question.

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

PubMed: “Cardiopulmonary Resuscitation” OR “Cardiac Compressions” OR “Chest Compressions’ as MeSH (heading) AND “Neonatal” OR “Newborn” OR Infant

Cardiopulmonary Resuscitation… and Neonatal (430 hits), and Newborn (420 hits) and Infant (676 hits)

Chest Compressions and Newborn… (83 hits), and Infant (74 hits), and Neonatal (85 hits)

PubMed, EMBASE, Cochrane Library, SCOPUS, AHA Endnote Database, hand review of references of articles of relevance

### State inclusion and exclusion criteria

**Inclusion:** Human and animal, neonatal or neonatal model studies, articles truly dealing with hand placement during neonatal cardiac compressions, editorials and review articles included but only used for hand-searching for further references, English Only

**Exclusion:** Adult clinical and model studies, abstract only

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

**PubMed/EMBASE:** 11

Hand Review of references of articles of relevance: 2

Of these none were LOE1, none were LOE 2, none were LOE 3, 3 were LOE 4, nine were LOE 5, 1 review article with no new data
## Summary of evidence

### Evidence Supporting Clinical Question

<table>
<thead>
<tr>
<th>Level of Evidence</th>
<th>Study 1</th>
<th>Study 2</th>
<th>Study 3</th>
<th>Study 4</th>
<th>Study 5</th>
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| Good              |         |         |         | Dorfsman, 2000 p1077<sup>E</sup>  
|                   |         |         |         | Houri, 1997 p65<sup>E</sup>  
|                   |         |         |         | Martin, 2004 p711<sup>E,F</sup> |
| Fair              |         |         | David, 1988 p552<sup>E</sup>  
|                   |         |         | Maher, 2009 p662<sup>F</sup>  
|                   |         |         | Menegazzi, 1993 p240<sup>E</sup>  
|                   |         |         | Whitelaw, 2000 p213<sup>F</sup>  
|                   |         |         | Udassi, 2009 p328<sup>E</sup>  |
| Poor              |         |         | Todres, 1975 p781<sup>E</sup>  
|                   |         |         | Clements, 2000 p43<sup>E</sup>  
|                   |         |         | Dawkins, 2008 p63<sup>F</sup>  
|                   |         |         | Thaler, 1963 p606<sup>E</sup>  |

**Level of evidence**

- **A** = Return of spontaneous circulation
- **B** = Survival of event
- **C** = Survival to hospital discharge
- **D** = Intact neurological survival
- **E** = Other endpoint (blood pressure)
- **F** = Other endpoint (depth of compression)

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

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<tr>
<td>Poor</td>
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<td>Moya, 1964 p798(^{E})</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 Opposing Clinical Question

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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*
REVIEWER'S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:

There is a complete lack of randomized clinical data regarding use of two-thumb versus two-finger cardiac compression technique in newborns. Case reports totaling 4 of 5 infants who had umbilical arterial catheters in place at the time of CPR (not in the delivery room) and received cardiac compressions via both methodologies suggest better perfusion pressures with the two-thumb technique. This finding is consistent with the majority of data from manikins and animal models. A single infant case series (n=6) demonstrated that the two-thumb method can achieve adequate systolic and diastolic pressures during CPR. However, not a single report describes whether the cardiac compressions were actually successful in achieving return of spontaneous circulation or some other clinically important outcome other than blood pressure. Of note there is not a single neonatal study that has evaluated either the two-thumb or two-finger method using currently recommended neonatal compression to ventilation ratios or that have evaluated compressor fatigue over time in either neonatal models, manikins or clinical practice. The randomized evidence comes from infant animal models and manikins all of which consistently show better blood pressure maintenance and more accurate and consistent depth of compression when using the two-thumb method. Three studies mentioned compression provider preference for the two-thumb method but no quantitative evidence is provided.

Acknowledgements: NIL

Papers included in grid

David, 1988 p552E

LOE: 4
Quality: Fair (to Poor given extremely small number of infants)
Supportive/Neutral/Opposing: Supportive evidence that the Two-Thumb Method is Superior
Industry Funding: No report of funding
Comments: Very small case series of 2 preterm infants in the NICU environment with umbilical lines in place at the time of cardiopulmonary arrest (asystole). Each infant served as own control with the two-finger and then the 2 thumb method of chest compressions used and the MAPs generated compared. The 2 thumb method was able to generate superior MAPs and a higher diastolic blood pressure (thus theoretically improving coronary perfusion pressure). However, caution must be taken for an n of 2! Also compression to ventilation ratio was 5:1 rather than 3:1 as currently recommended.

Dawkins, 2008 p63E

LOE: 5
Quality: Poor for the purposes of neonatal resuscitation and this specific PICO question
Supportive/Neutral/Opposing: Supportive evidence that the Two-Finger Method is ineffective for cardiac compressions
Industry Funding: No industry funding. Funding via UK Resuscitation Council
Comments: This is a study of 52 lay people videoed while performing CPR on an infant (9 mo size) manikin while receiving phone instruction from a simulated emergency dispatch operator. Participants were instructed to provide chest compressions with a 2 finger technique and not a single person was able to give compressions at an adequate depth. The study was not a comparison between the 2 thumb and 2 finger technique and the model was one of an older infant but the fact that not a single participant could achieve the appropriate depth
of compression is concerning. In addition note that a 5:1 compression to ventilation ratio was provided rather than 3:1 as recommended for neonates.

**Dorfsman, 2000 p1077**


**LOE:** 5 (manikin study)

**Quality:** Good

**Supportive/Neutral/Opposing:** Supportive evidence that the Two-Thumb Method is more effective for cardiac compressions

**Industry Funding:** No report of any type of funding

**Comments:** Infant manikin study but investigators designed an "arterial circuit" to get some handle on perfusion issues. 21 BLS providers were randomized to the two-thumb versus two-finger technique during a 10 minute rescue period with 5 compressions for every ventilation pause (note: no actual ventilation was provided). Each participant served as their own control as they were later studied using the opposite technique (2 to 14 days later). The two-thumb method generated higher artificial MAP, SBP, DBP and PP when compared to the two-finger method. Both methods saw decay in pressures generated over time. Study participants reported a "preference" for the two-thumb method (no objective measure) due to a sense that it was easier to do and less tiring. Lots of data massaging for statistical analysis but likely ok. Would have been even better if investigators analyzing the data were blinded to the compression method but no mention made of that.

**Houri, 1997 p65E**


**LOE:** 5 (animal model)

**Quality:** Good

**Supportive/Neutral/Opposing:** Supportive evidence that the Two-Thumb method is superior

**Industry Funding:** No industry funding. Funding via UK Resuscitation Council

**Comments:** Model was an infant (not neonatal) piglet model of asphyxia with no detail given as the method of asphyxiation but was a rapid induction (took 7-10 minutes to reach asystole). After 10 minutes of asystole, ventilation was provided and BLS providers were randomized to either two-thumb or two-finger technique (with and without feedback) for one minute intervals with cross-over. This is a very short time interval. There is no description of what compression to ventilation ratio was used nor any assessment of the adequacy of ventilation. Rate of compressions was standardized with use of a metronome. No a priori statistical analysis was performed. Appears to be a convenience sample. Could have been a stronger study if the investigator analyzing the blood pressures and sternal compression forces had been blinded to the type of compression technique but no mention was made of attempting this. Two-thumb method generated higher systolics and sternal compression forces. However, diastolic blood pressure which is what contributes to coronary perfusion pressure was unchanged (authors didn't even mention this). No actual outcome data such as return of spontaneous circulation reported. By report the study participants "preferred" the two-thumb technique (no objective measure) because they felt it was easier and less tiring.

**Maher 2009 p662**


**LOE:** 4 (small case series of infants )

**Quality:** Fair to poor for the PICO question at hand
Supportive/Neutral/Opposing: Supportive evidence that the Two-Thumb method can achieve appropriate depth of compression (but no comparison group)
Industry Funding: No industry funding.
Comments: Small case series of post-op cardiac surgery infants who received cardiac compressions with the two-thumb method. 1/3 AP diameter could be achieved although authors question whether a deeper question might result in better perfusion, the diastolic blood pressure (determinant of CPP) was not different between 1/3 and 1/2 AP diameter. No info on Two Finger technique.

Menegazzi, 1993 p240E

LOE: 5 (animal model)
Quality: Fair (not a good model for neonatal arrest)
Supportive/Neutral/Opposing: Supportive evidence that the Two-Thumb method is superior
Industry Funding: No funding source reported
Comments: This is a fairly well designed randomized, crossover trial comparing the Two-thumb and Two-finger technique for cardiac compressions in an infant swine model of KCl induced cardiac arrest (v-fib) which is not a common cause of neonatal arrest. Compression intervals were very short at 1 minute apiece and thus this study provides little information regarding fatigue over time. Systolic, diastolic, MAP and coronary perfusion pressure will higher using the two-thumb technique. Ventilation was provided but the specific compression to ventilation ratio was not described and ventilation was not standardized. Compression force was not standardized either. No a priori sample size calculations offered.

Moya, 1962 p798E

LOE: 4 (small case series)
Quality: Poor
Supportive/Neutral/Opposing: Opposing/neutral evidence that the two-thumb method is superior. Suggests two-finger method achieved higher systolic blood pressure but there was no difference in diastolic blood pressure attained which is critical to coronary perfusion pressure
Industry Funding: No funding report made
Comments: Case series of 5 newborns who received CPR but only one had umbilical line placed and both the two-thumb and two-finger method tried with blood pressures recorded. As opposed to all other studies reviewed, this case report found higher systolic blood pressure with the two-finger technique. However, both techniques generated adequate diastolic blood pressure which is a more important determinant of coronary perfusion pressure.

Thaler, 1963 p606E

LOE: 5 (cadaver study)
Quality: Poor
Supportive/Neutral/Opposing: Supportive evidence that the two-thumb method is superior
Industry Funding: No funding report made
Comments: Report regarding cardiac compressions in infants with a series of hemodynamic pressure experiments performed on 20 cadavers that had been heparinized within 15 min of death followed by 10
minutes of external cardiac compressions. Systemic pressures were measured using a mercury manometer connected to a femoral arterial catheter. In order to attain the same systolic pressures, the two-finger method required more external force than the two-thumb method. The methods are not well described and no actual data is presented. No sample size calculations. No ventilation provided.

Todres, 1975 p781E

LOE: 4 (Single case report with infant as own control)
Quality: Poor
Supportive/Neutral/Opposing: Supportive evidence that the two-thumb method is superior
Industry Funding: No funding report made
Comments: Single case report of a newborn in the NICU with an umbilical line who received CPR by both methods. The two-thumb method resulted in higher MAP and DBP (and thus should have had better coronary perfusion pressure) compared to the 2-finger method.

Udassi, 2009 p328F

LOE: 5 (Manikin Study)
Quality: Fair
Supportive/Neutral/Opposing: Supportive evidence that the two-thumb method is superior
Industry Funding: No funding report made
Comments: Each participant randomized to 4 different techniques that included Two-finger and Two Thumb but using the pediatric/adult ratio of 30:2 rather than neonatal paradigm. Subjects were blinded to depth of compression results. Two thumb raised the rescuers heart rate but provided better depth of compression and compression rate.

Whitelaw, 2000 p213E

LOE: 5 (Infant Manikin Study)
Quality: Fair
Supportive/Neutral/Opposing: Majority of data showed neutrality between the two methods but in one area there was supportive evidence that the two-thumb method is superior
Industry Funding: No funding report made
Comments: 209 BLS providers were randomized for 1 min intervals of either the two-thumb or two-finger cardiac compression method. They had a short break and then crossed over to the alternate method for another minute. This short interval provides no useful information about decay of quality of compressions over time. The compressions were delivered at 100 bpm in rhythm with a metronome and no ventilation was provided (quite different from the neonatal clinical situation). An a priori sample size calculation was performed. Regardless of level of training, the vast majority of providers failed to obtain or maintain good compressions with either method. The two-thumb method did provide for less frequency of compressions that were too shallow.

Articles reviewed but not included
Clements, 2000 p43E

LOE: 5
Quality: Poor
Supportive/Neutral/Opposing: Supportive evidence that the Two-Thumb method might be superior
Industry Funding: No report of funding
Comments: 30 infants (0-52 weeks) of whom only 7 were neonates had sternal length measurements taken and the breadth of 3 compressing fingers for 30 adults were measured and compared. The authors suggest that this technique will typically result in pressure on the xiphoid or abdomen which should be avoided. However, the current recommendation is only for 2 fingers so concern may not be as warranted under current guidelines. No comparison was made of breadth of thumbs.

Martin, 2004 p711E,F

LOE: 5
Quality: Good
Supportive/Neutral/Opposing: Supportive evidence that the Two-Thumb method is superior
Industry Funding: No report of funding source
Comments: Best evidence topic report that is a systematic review of the 2 randomized trials using animal models and 2 randomized trials using manikin models to evaluate the two-thumb versus two-finger technique. The review came to the conclusion that the two-thumb method produces improved hemodynamic states in experimental models and should be used when possible in preference to the two-finger technique. All included papers are individually reviewed in my worksheet

Thaler, 1964 p844
Comments: No new data compared to NEJM article by same name so not included

Wyckoff, 2008 p410
Comments: Review article-no new data