Clinical question.

For intubated term or near-term newborns within the first month of life (beyond the delivery room) who are receiving chest compressions (P), does the use of continuous chest compressions (without pause for ventilation) (I) vs. chest compressions with interruptions for ventilation (C) improve outcome (time to sustained heart rate >100, survival to ICU admission, survival to discharge, survival with favorable neurologic status) (O)?

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

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

Search strategy (including electronic databases searched).

PubMed – (1) “Heart arrest” and “cardiopulmonary resuscitation” as MeSH headings, limit birth – 23 months (424 hits).
(2) “Simultaneous compression and ventilation” – limit birth – 23 months (no hits)
(3) “Chest compressions and ventilation,” limit birth – 23 months (56 hits)
Cochrane Library – “Resuscitation” (125 hits)
EMBASE – “Cardiopulmonary resuscitation” and “neonates” (81 hits)
AHA EndNote database

State inclusion and exclusion criteria

Excluded editorials, letters to the editor.
Excluded studies not involving cardiac arrest
Excluded studies using abdominal binding or vest CPR as part of the resuscitation technique

Number of articles/sources meeting criteria for further review:

articles met criteria for further review
# Summary of evidence

## Evidence Supporting Clinical Question

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<th>Level of evidence</th>
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<td>Whyte 1998 (E) Babbs 2009 (E)</td>
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<td>Berkowitz 1989 (E) Luce 1983 (E)</td>
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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
### Evidence Neutral to Clinical question

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<td>Berg 1999 (A,B)</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
There are two basic questions being addressed in this worksheet: For neonates outside of the delivery room, 1) are the frequent interruptions in CPR using the neonatal 3:1 compression:ventilation ratio with pause for ventilations advantageous or detrimental to resuscitation success? and 2) is the use of continuous chest compressions with asynchronous ventilation, as is practiced for intubated infants beyond one month of life, advantageous or detrimental to resuscitation success?

The question has clinical relevance in that neonates who remain in a NICU setting and suffer cardiopulmonary arrest will receive CPR at a different compression:ventilation ratio than neonates who are discharged from the hospital then require resuscitation from cardiac arrest. Furthermore, neonates with congenital heart disease or other surgical problems are frequently hospitalized in pediatric or cardiac ICUs that are likely to be staffed by providers who are trained to perform CPR on infants using asynchronous compressions and ventilations as they would for infants beyond one month of life.

Unfortunately there have been no human or animal studies directly comparing the two methods of cardiopulmonary resuscitation.

Acknowledgements:

Citation List


LOE 5 study (mathematical model). This model focused exclusively on the rate of chest compressions and its effect on systemic perfusion pressure. Maximum perfusion pressure occurred at chest compressions of ~180/min for infants weighing 3 kg. While this model does not take into account the need for ventilation, it is noteworthy that continuous chest compressions at 180/min is significantly different than chest compressions at ~90/min when pauses for ventilations are performed during neonatal resuscitation at a 3:1 ratio.


LOE 4 (Retrospective case series). The authors defined cardiac arrest as “an acute episode of hypotension, bradycardia, and/or peripheral hypoperfusion for which infants were treated with mechanical ventilation and external cardiac massage, and/or a bolus of atropine or adrenaline.” Of the 35 infants who were categorized as having cardiac arrest, 32 (91%) received chest compressions, 15 (43%) survived to hospital discharge, and 2 (6%) survived without long-term neurodevelopmental sequelae. Of note, the survival rate to hospital discharge for infants with congenital heart disease was only 20%. The precise technique for performing CPR was not described, and the study took place in Australia between 1991 and 1997.


LOE 5: This animal study looked at the difference in outcome between piglets receiving chest compression-only CPR vs. chest compressions with ventilations in a 5:1 ratio with a pause for simulated mouth-to-mouth ventilations. Cardiac arrest was induced by clamping the endotracheal tube (ie, asphyxial cardiac arrest). Outcome (ROSC and 24-hour survival) was better when chest compressions and ventilations were both performed.

LOE 5: This animal study evaluated myocardial and cerebral blood flow and cerebral oxygen uptake in infant swine (3.5–5.5 kg) that received conventional CPR (5:1 compression-to-ventilation ratio) vs. those treated with simultaneous chest compressions and ventilations. After five minutes, myocardial blood flow was increased in the SCV group, and there was no significant difference in cerebral blood flow. Both methods became less effective after prolonged resuscitation (50 min). Of note, the technique used for SCV CPR involved applying 60 mm Hg airway pressures with each chest compression, which is more frequent and likely to be higher than inflating pressures used during CPR in infant humans. The results suggest that SCV CPR might be advantageous for myocardial blood flow during brief periods of cardiac arrest.


LOE 5: This animal study compared conventional CPR at a 5:1 compression-to-ventilation ratio with SCV-CPR in infant piglets (13.7+/1.2 kg). Of note, the compression-to-ventilation ratio for the SCV group was 1:1, with a peak airway pressure of 60 cm H2O. Cardiac output and blood pressures were similar between the two groups during the first 30 min of CPR, although coronary perfusion pressure rapidly decreased in both groups. Blood gases were more severely impaired with SCV-CPR.


LOE 5 (Mannikin study) – The authors measured effective compression and ventilations at various ratios. Not surprisingly, a 3:1 ratio produced the highest ventilatory rate and 15:2 resulted in the highest compression rate.


LOE 5 (animal study) – True cardiac arrest model although methods indicate “chemically-induced cardiac arrest.” The authors found no difference in ventilation:compression ratios of 1:2, 1:3, or 1:4 in terms of respiratory or hemodynamic parameters, but 1:3 produced the greatest carbon dioxide production.


LOE 5: This mannequin study evaluated the ability of clinicians to achieve the recommended rates of chest compressions and ventilations using a 3:1 ratio during two-rescuer CPR. Less than 25% of paired providers were able to achieve 40 breaths per minute. This study suggests that the use of a 3:1 ratio to achieve a higher minute ventilation may be less effective than believed.


There is a paucity of data to support the recommendations for cardiac compressions for the newly born. Techniques, compression to ventilation ratios, hand placement and depth of compression guidelines are generally based on expert consensus, physiologic plausibility, as well as data from pediatric and adult models. The limited information that exists is reviewed.

LOE 5 (Review article)