**Clinical question.**

"In neonates receiving positive pressure ventilation (P) does the use of gas volume monitoring (I) versus clinical assessment with or without pressure monitoring (C) improve clinical 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

**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).**

- “Resuscitation” (MeSH) and “newborn or infant” (text word) and “birth” (text word) 2020 hits, 10 selected for further review
- “Resuscitation” (MeSH) and “tidal volume” (text word) and infant (text word) 365 hits, 4 selected for further review

AHA Neonatal Library, Cochrane Database for Systematic Reviews, Central Register of Controlled Trials, DARE, Web of Knowledge (ISI) no relevant articles identified

Review of references from key articles and personal files; 3 relevant references identified

**Date of initial search:** 2/4/09  **Date of most recent update:** 12/15/09

- **State inclusion and exclusion criteria**
  - Inclusion criteria: All studies of gas volume during PPV with bag-mask or other resuscitation device using direct or indirect evaluation of quality or quantity (i.e., pressure or volume); animal studies evaluating initial ventilation strategies or ventilation during resuscitation
  - Exclusion criteria: Studies of long-term mechanical ventilation only; descriptive and review studies

- **Number of articles/sources meeting criteria for further review:** 12
## Summary of evidence

### Evidence Supporting Clinical Question

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<thead>
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<th>Good</th>
<th>Fair</th>
<th>Poor</th>
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| Kattwinkel E2  
Kobr E2  
Lee E2  
Probyn E1  
Wada E1  
Wallace E2 |
| Bassani, E3  
Resende, Menezes E2  
Resende, Zaconeta E3 |
| Scavacini E2 |

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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
- **E1** = Tidal volume and outcome
- **E2** = Tidal volume delivery during PPV
- **E3** = PPV performance
- **Italics** = Animal studies
### Evidence Neutral to Clinical question

| Good | | | | | O'Donnell E2  
| Fair | | | | |
| Poor | | | | |

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Level of evidence

A = Return of spontaneous circulation  
B = Survival of event  
E1 = Tidal volume and outcome  
E2 = Tidal volume delivery during PPV  
E3 = PPV performance

### Evidence Opposing Clinical Question

| Good | | | | |
| Fair | | | | |
| Poor | | | | |

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Level of evidence

A = Return of spontaneous circulation  
B = Survival of event  
E1 = Tidal volume and outcome  
E2 = Tidal volume delivery during PPV  
E3 = PPV performance
No studies were identified that specifically investigated the use of gas volume monitoring during resuscitation of newborns in the delivery room. Several LOE 5 studies demonstrated that, if monitoring is not provided, health care providers do not deliver consistent pressures and/or tidal volumes during positive pressure ventilation in model systems (Bassani 2009, 217; Kattwinkel, 2009, 465; Lee, 2008, 632; Resende, 2006, 359) or preterm lambs (Resende, 2006, 279), nor could they maintain the tidal volumes and/or pressures within a target range. One LOE 5 study (Kattwinkel, 2009, 465) suggests that providing real-time information regarding performance of PPV improves provider performance; however, another LOE 5 study (O’Donnell, 2005, F397) found no improvement in the consistency or efficacy of PPV when the provider could view a monitor while ventilating a test lung. Evidence from 3 studies in preterm lambs (Kobr, 2008, 45; Wada, 1997, 1054; Wallace, 2009, 19) suggests that ventilation with high tidal volumes increases lung injury, alters gene expression in the lungs, and decreases the response to exogenous surfactant; a single animal study (Polglase, 2008, 517) found no difference in lung injury using a tidal volume of 5 ml/kg or 10 ml/kg for ventilation. However, it is possible that even the lower tidal volume used in this study was excessive.

Based on the evidence that providers frequently use excessive tidal volumes when providing positive-pressure ventilation if gas volume is not monitored, and that use of excessive volumes is associated with lung injury in animal models, it appears that a method to ensure that appropriate tidal volumes are consistently delivered during resuscitation could improve pulmonary outcomes, particularly in preterm infants. However, before such a strategy could be implemented, further studies are needed to determine the optimal methods for monitoring tidal volume and/or peak pressure, and to establish the appropriate target ranges for term and preterm infants.

Citation List


LOE 5, Fair, supports. Providers using a self-inflating bag tended to deliver excessive tidal volumes and peak pressures to a test lung.


LOE 5, Good, supports. Study in newborn lung model. Volume delivered during bag-mask ventilation was more consistent when the subject could see the volume being delivered on a monitor.


LOE 5, Good, supports. Mechanical ventilation with high tidal volumes caused lung injury and an inflammatory response in juvenile piglets.


LOE 5, Fair, supports. Tidal volumes delivered via bag-mask ventilation to test lung varied widely in the absence of volume monitoring.


LOE 5, Good, neutral. Subjects who could see manometer readings while delivering PPV to a mannequin with bag mask did not deliver more consistent pressures or tidal volumes than those who could not see the manometer.

LOE 5, Good, neutral. No difference seen in lung injury in preterm lamb model using TV of 8 ml/kg vs 15 ml/kg. However, it may be that even a TV of 8 ml/kg is excessive in this model.


LOE 5, Good, supports. Preterm lambs ventilated with bag-mask using TV of 10 ml/kg (vs 5 ml/kg) became hypocarbic within 15 minutes.


LOE 5, Fair, supports. Physicians providing PPV with self-inflating bag to a lung model were not able to consistently deliver a target pressure. Volume not measured but likely that results would be similar.


LOE 5, fair, supports. Physicians providing PPV to intubated preterm lambs via self-inflating bag frequently delivered excessive tidal volumes at levels that have been shown to cause lung injury.


LOE 5, Poor, supports. Physicians at various levels of training were unable to assess tidal volume by observing chest rise in neonates receiving mechanical ventilation. “True” tidal volumes were calculated from a data base.


LOE 5, Good, supports. Mechanical ventilation with high tidal volume increased lung injury and decreased response to exogenous surfactant in preterm lamb model.


LOE 5, Good, supports. High tidal volume ventilation altered gene expression in lungs of preterm lambs.