## Clinical question.
In neonates (P) receiving positive pressure during resuscitation, is positive pressure ventilation by T-piece resuscitator (I) superior to bag ventilation (C) for improving outcome - specify (O)?

<table>
<thead>
<tr>
<th>Is this question addressing an intervention/therapy, prognosis or diagnosis?</th>
<th>Intervention</th>
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<tbody>
<tr>
<td>State if this is a proposed new topic or revision of existing worksheet</td>
<td>Subsidiary question from a previous worksheet</td>
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<th>Conflict of interest specific to this question</th>
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<tr>
<td>Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet?</td>
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### Search strategy (including electronic databases searched).

The subject area was included in a previous worksheet for C2005. I included relevant articles from the earlier worksheet. To look for new data on the subject I searched all new material from Jan 2004 to September 2009.

I searched the Cochrane database using the keywords resuscitation, newborn; mask ventilation, newborn; and T-piece, newborn and identified no reviews or registered trials.

I searched Pub Med using the following keywords and in all cases limited to articles with abstracts:
- Resuscitation and newborn 1534 hits.
- Positive pressure ventilation and newborn 480 hits
- T-piece 48 hits
- Mask ventilation 84 hits

I searched Embase for the same time period with the following terms, limited to articles with abstracts
- Resuscitation and newborn 793 hits
- Positive pressure ventilation and newborn 112 hits
- T-piece 157 hits
- Mask ventilation 220 hits.

### State inclusion and exclusion criteria

All titles and abstracts were reviewed. Articles were selected as relevant if they described the use of both devices in some way that would permit comparison for initial resuscitation after birth in humans or in relevant animal models or bench models. Reference lists of selected articles were reviewed for further possible articles. Review articles and articles describing surveys of practice were not included.

### Number of articles/sources meeting criteria for further review: 7, all were LOE 5
## Summary of evidence

### Evidence Supporting Clinical Question

<table>
<thead>
<tr>
<th>Level of evidence</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tr>
<td>Good</td>
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<td>Fair</td>
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<td>Poor</td>
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</tbody>
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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

| Fair | | | | |
| Poor | | | | |

| 1 | 2 | 3 | 4 | 5 |

**Level of evidence**

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

**Italicics** = Animal studies

### Evidence Opposing Clinical Question

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

| 1 | 2 | 3 | 4 | 5 |

**Level of evidence**

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

**Italicics** = Animal studies
The main aim in performing intermittent positive pressure ventilation during newborn resuscitation is to deliver effective lung inflation. In most cases this is all that is required. The main criteria for evaluating devices for this purpose should be that this can be achieved with the minimum of difficulty and maximum efficacy. However beyond this simple aim, there is increasing interest in the extent to which more control can be exerted over the inflation patterns, varying inspiratory pressure, inspiration time and providing positive end expiratory pressure. These characteristics are increasingly being studied (see worksheet NRP 028B), particularly in relation to resuscitation of preterm infants but studies have not so far resulted in evidence sufficient to generate evidence based guidelines for practice indicating that these additional facilities are important enough to be recommended routinely. The primary focus of the worksheet is therefore on delivering simple IPPV with secondary consideration given to these other characteristics.

In some respects the PICO question is too generalized because there are two forms of T-piece (those whose design permits the delivery of positive inspiratory pressure alone and those which also allow positive end-expiratory pressure to be generated) and 2 forms of bag ventilation system (self-inflating bag and flow-inflating bag) both of which can be adapted to support the use of PEEP. In the main, these distinctions are not important because to answer the PICO question reliably would require a trial comparing 2 types of equipment in newly born human infants in need of resuscitation, with a clinically relevant outcome measure that was likely to influence practice. No such evidence exists. These classes of device have not been compared directly at all in newly born human infants. International surveys of practice indicate that T-pieces, self-inflating bags, and flow-inflating bags are all in widespread use. There is no new evidence since 2005 to change the recommendation made in 2005 that “Studies on humans and manikins suggest that effective ventilation can be achieved with either a flow inflating or self-inflating bag or with a T-piece mechanical device designed to regulate pressure.”

Regarding the ability of the user to control ventilation patterns more closely, seven studies were identified that compared the two types of device in bench tests using manikins or test lungs. No human studies were identified. These studies evaluate the ability of the user to perform various components of the task of ventilation, evaluating the inflation pressures and volumes generated, the ability to control these pressures and volumes, the ability to generate a sustained inflation, the ability to deliver positive end-expiratory pressure, the amount of leak around the mask. The importance of these individual attributes is uncertain because they have not been shown in human infants to influence outcome and it may not be safe to assume that the same findings would be observed in the human setting under the pressure of a real-life resuscitation. It is not easy to assess the importance of leak from a continuous flow device in comparison with a non-continuous flow device. Mask leaks observed in manikins may not replicate those in human infants. The added pressure and distraction in the real life situation is likely to change behaviours. All of the following research findings come from bench tests in manikins and lung models.

Positive end-expiratory pressure can be delivered consistently without difficulty during IPPV using a T-piece device (Bennett, Finer). No significant PEEP is delivered by a self-inflating bag unless a PEEP valve is employed (Bennett, Hussey). PEEP generated with a PEEP valve and self-inflating bag in these bench evaluations is lower than the set target and variable (Bennett). PEEP can be delivered using a flow-inflating bag but less consistently than with a T-piece device and perhaps only by more skilled operators (Bennett, Finer).

Sustained inflations can be delivered without difficulty using a T-piece device and with a flow inflating bag but when the flow inflating bag is used they are shorter and at lower pressure than with a T-piece device (Bennett, Oddie, Finer). Sustained inflations cannot be delivered reliably with a self inflating bag (Bennett, Oddie).

A target peak inspiratory pressure is more easily controlled using a T-piece device than with bag ventilation (Bennett, Finer, Hussey, Oddie). However the peak inspiratory pressure generated is not a reliable proxy for the tidal volume generated as this relationship can be highly variable (O’Donnell 2005, O’Donnell 2005b). Making adjustments in PIP may take longer with a t-piece than with bag ventilation (Bennett). When the compliance of a test lung was varied, experienced resuscitators were slightly better at maintaining target tidal volume with a self-inflating bag than with a T-piece device or a flow-inflating bag (Kattwinkel). However this was in an intubated model and when self inflating bags are used in intubated models without a manometer, very high inflation pressures can be generated even when there is a pressure blow off valve in the system (Hussey, Oddie). These high pressures have not been observed in bench studies evaluating mask ventilation with self-inflating bags, perhaps because mask leaks limit the peak pressures generated (O’Donnell 2005, O’Donnell 2005b).
These bench data are of interest to those responsible for providing advanced resuscitation and stabilization, particularly for preterm infants but because they describe ventilation characteristics rather than outcomes they cannot be considered supportive to the PICO question.

Acknowledgements:

Citation List


Comment – LOE 5 Quality fair. Neutral to main PICO question. Experienced resuscitators mask ventilating a mannikin. Closer control of PIP was achieved with T-piece. More consistent PEEP was obtained with T-piece than with self-inflating bags with PEEP valves or with flow-inflating bags. Better sustained inflation obtained with T-piece. Time taken to adjust pressure settings with T-piece was longer.


Comment - LOE 5 Quality fair. Neutral to main PICO question. Experienced resuscitators mask ventilating a mannikin. Neopuff or flow inflating bags. Closer control of PIP was achieved with neopuff. More consistent PEEP was achieved with neopuff. Only the more experienced subjects could deliver PEEP with the flow-inflating bag. More success in delivering sustained inflation with neopuff.


Comment – LOE 5 Quality fair. Neutral to main PICO question. Experienced resuscitators ventilating an intubated manikin with a manometer. Self inflating bag delivered very high peak pressures. Control of pip better with anaesthetic bag or neopuff.


Comment– LOE 5 Quality fair. Neutral to main PICO question. Experienced resuscitators ventilating an intubated test lung system with a pressure manometer or a volume monitor. The test system changed compliance without warning. It doesn’t appear that the subjects could see the lung but they could see either a pressure display or a volume display. There was a greater ability to sense and respond to changes in lung compliance with a self inflating bag than with a T-piece or anaesthesia bag. Display of volume rather than pressure facilitated the delivery of effective ventilation under circumstances of changing compliance. Differences between devices were smaller when volume was displayed but were still present. It is important to recognize that the findings may not be the same with mask ventilation in a mannikin or a human. Only a tiny proportion of babies who are given IPPV at birth are intubated. Other studies suggest that very high pressures may be generated by self-inflating bags in intubated patients. In this study mean pressures were reported but not peak pressures.

Comment - LOE 5 Quality fair. Neutral to main PICO question. Experienced resuscitators ventilating the equivalent of an intubated lung. Sustained inflations were more effectively delivered by T-piece than by self-inflating bag. Ventilation by bag generated v. high peak pressures. More inflations were within target pressure range with T-piece than with self inflating bag.


Comment - LOE 5 Quality fair. Neutral to main PICO question. Participants of varied experience levels mask ventilated a manikin by self-inflating bag plus manometer or by neopuff. Similar PIP was generated with the 2 devices. Larger tidal volumes were generated by the self-inflating bag. More leak was observed with T-piece. PIP generated was a poor proxy for tidal volume.


Comment - LOE 5 Quality fair. Neutral to main PICO question. Experienced staff used laerdal bag with manometer or neopuff to mask ventilate a mannikin. Pressures generated using the bag were very variable and lower than target. Tidal volumes were slightly higher with the bag. Leak was similar. Manometer did not help much.