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

Worksheet author(s)

	Date Submitted for review: January 27, 2010

Clinical question.

In newborns **(P)** requiring positive pressure during resuscitation, is positive pressure ventilation by T-piece resuscitator **(I)** superior to bag ventilation **(C)** for improving outcome - specify **(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: 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).

Medline was searched for articles from 1950 to present. The initial Medline search combined the terms *resuscitation/ or cardiopulmonary resuscitation; positive-pressure respiration/ or respiration, artificial; and infant, newborn/ or infant, small for gestation/ or infant, postmature*. As the search strategy was an extension of the strategy employed for W203A from c2005, the results were limited to publication years 2002-2010. A second search was conducted using the above MESH terms with the addition of *asphyxia neonatorum*.

- State inclusion and exclusion criteria

Only studies published in full in peer-reviewed journals were included. Excluded studies from stillborn infants and isolated lung preparations.

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

The initial search yielded 104 articles for consideration. The second strategy yielded 67 (some of these articles were identical to those obtained from the initial search. A supplementary search conducted in January 2010 including the period from 2008-2010 yielded 40 articles for consideration. A total of 24 articles are included for review. Of these 1 was LOE 1, 0 LOE 2, three LOE 3, one LOE 4, and 19 LOE 5.

Summary of evidence

Evidence Supporting Clinical Question

Good					Bennett 2005 Oddie 2005
Fair				Hoskyns 1987 Vyas 1981	Finer 2001 Hussey 2004 Morley 2009 O'Donnell 2005a O'Donnell 2005b
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
Italics = Animal studies

Evidence Neutral to Clinical question

Good					Reise 2009
Fair			Allwood 2003 Milner 1984	Finer 2004	Dawson 2007 Leone 2006 O'Donnell 2004a O'Donnell 2004b Wood 2008a Wood 2008b Wood 2008c
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
Italics = Animal studies

Evidence Opposing Clinical Question

Good					Kattwinkel 2009
Fair					Hawkes 2009a McHale 2008
Poor					Hawkes 2009b
	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
Italics = Animal studies

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

The performance of T-piece resuscitators has been compared with self-inflating and flow-inflating bags while ventilating manikins or a lung simulator by mask or by endotracheal tube. Target inflation pressures were delivered more reliably with T-piece devices than with flow-inflating bags {Hussey 2004, Oddie 2005, Finer 2001} In addition, PEEP was maintained more consistently with the T-piece device compared with flow-inflating bags {Finer 2001}. O'Donnell et al studied ventilation of a modified manikin using a 240-mL self-inflating bag attached to a manometer or a T-piece resuscitator using a round or anatomically shaped mask {O'Donnell 2005a}. They tested 34 caregivers using the combination of both devices and masks and monitored delivered pressures and volumes. The target peak airway pressures were generated reliably using the self-inflating bag with a manometer or the T-piece resuscitator. Although there was little variation in the delivered pressures, there was considerable variation in the volumes delivered with the different devices. This variation was attributed to large variations in the amount of leak around the mask. Further evaluation of manometer use during simulated resuscitation showed that there was no difference in peak inspiratory pressure, expired tidal volume, or face mask leak with or without a manometer using either a self-inflating bag or a T-piece resuscitator {O'Donnell 2005b}.

Recently, Wood et al published a series of papers assessing a variety of interventions to reduce face mask leak. All studies were conducted using a T-piece resuscitator and a modified baby manikin. Participants included a wide range of professionals with varying degrees of experience. Mask leak was assessed between 2 different manufacturers' round masks comparing 4 techniques of mask application to form a seal {Wood 2008a}. The mean percentage leak at the face mask was 55% to 57% with no significant difference between the 2 types of mask. Mask leak varied widely for all professional categories, without the ability to accurately self-assess actual leak. Educational strategies combining written instructions on how to hold the face mask along with a visual demonstration reduced mask leak by 24% {Wood 2008b}. Face mask leak was reduced from 27% to 11% when test subjects were taught to achieve minimal mask leak by observing inspired and expired tidal volumes using a respiratory function monitor {Wood 2008c}.

Bennett et al examined the ability of a wide variety of personnel to deliver a consistent peak inspiratory pressure (PIP) and positive end-expiratory pressure (PEEP), to maintain a 5 second inflation, and the time to transition from a lower to a higher PIP using a T-piece resuscitator, a flow-inflating bag, and a 450-mL self-inflating bag {Bennett 2005}. All studies were conducted using a neonatal manikin. The T-piece resuscitator was more precise and consistent in delivering a PIP of 20 cm H2O than the self-inflating bag. The self-inflating bag with a PEEP valve in place provided significantly less PEEP than either the T-piece resuscitator or the flow-inflating bag. The ability to deliver a 5 second inflation pressure >18 cm H2O was also significantly lower using the self-inflating bag compared with either the T-piece resuscitator or the flow-inflating bag. Transition from a lower to a higher PIP took significantly longer with the T-piece device than with either the flow-inflating or the self-inflating bag. Morley et al further evaluated the delivery of PEEP using a self-inflating bag with an attached PEEP valve {Morley 2009}. The measured PEEP was lower than the set PEEP for all pressures and rates tested. In addition, PEEP declines rapidly between inflations.

Kattwinkel et al used a modified computerized lung model to evaluate the ability of test subjects to maintain a constant inflation volume while varying lung compliance using a flow-inflating bag, a self-inflating bag, and a T-piece resuscitator {Kattwinkel 2009}. A cardiopulmonary monitor was used to display delivered pressure and volume. Subjects were evaluated using all three devices with only pressure changes displayed and then with only volume displayed. When pressure only was displayed, there was no significant change in delivered pressure using the flow-inflating bag or T-piece resuscitator despite changes in lung compliance. A significant increase in delivered pressure was observed with the self-inflating bag in response to decreased compliance. When volumes were visible, subjects significantly, and appropriately, adjusted delivered pressures, however, changes were greater for the self-inflating bag than those for the flow-inflating bag or the T-piece resuscitator. The authors concluded that resuscitators respond better to changes in lung compliance if delivered volume is visible rather than pressure.

The use of T-piece resuscitators and self-inflating bags to deliver free-flow oxygen has been evaluated. When connected to a 100% oxygen source, the Neopuff Infant Resuscitator (Fisher and Paykel, New Zealand), a T-piece resuscitator, delivered 95 to 97% oxygen with the PEEP valve occluded or left open {Dawson 2007}. Reise et al demonstrated that the self-inflating bag connected to a compressed gas source with flow rates between 5-10 LPM delivered the same source FiO2 with or without an oxygen reservoir {Reise 2009}.

Recent studies have identified potential hazards with the use of the T-piece resuscitator. McHale et al demonstrated significantly increased inspiratory times in inexperienced resuscitators and wide variations in mean airway pressure and tidal volume across all levels of experience {McHale 2008}. In addition, distraction during ventilation produced

significant changes in inspiratory time, minute volume, tidal volume and respiratory rate across all levels of training. Hawkes et al showed that increasing the gas flow rate to the T-piece resuscitator can override the maximum pressure relief valve leading to potentially harmful peak inspiratory pressure and PEEP unless the settings on the device are reset {Hawkes 2009a} and suggested that use of the Neopuff T-piece resuscitator perhaps should be restricted to frequent users due to difficulties setting up the device by inexperienced users {Hawkes 2009b}.

There are few data describing the use of different devices in the resuscitation of newborn infants. No randomized studies comparing different devices were identified. Descriptive studies imply that all of these devices can be used safely and effectively in newborns and recent surveys confirm that self-inflating bags, flow-inflating bags, and T-piece resuscitators are all used in neonatal resuscitation. Flow-inflating bags are most commonly used in the United States while the self-inflating bag is the most commonly used device in Australia and New Zealand as well as internationally {Leone 2006, O'Donnell 2004a, O'Donnell 2004b}.

In 1981, Milner's group, pursuing their observations of the normal first breath, described the use of a pressure-limited T-piece device to deliver a prolonged slow rise inflation in the delivery room resuscitation of 9 newborns {Vyas 1981}.

In 1984, the same group published a study in which they compared the resuscitation of nine term or near-term infants with a self-inflating bag attached to a facemask with another group of nine term or near-term newborns resuscitated using a T-piece to deliver long inspiratory times (1–5 seconds) through an endotracheal tube {Milner 1984}. Although the expiratory volumes measured during resuscitation with the facemask were approximately one third of the volumes obtained during resuscitation with the ET tube, the less invasive method was sufficient to help the infants to start their own respiratory efforts. The authors attributed this result to the triggering of Head's reflex. Without citing the data, the authors reported that the first effective respiratory effort was achieved earlier in the group resuscitated with the facemask owing to the delay needed for the intubation procedure.

Hoskyns described mask resuscitation using a pressure-limited T-piece in 22 full-term infants delivered by cesarean section {Hoskyns 1987}. The advantage of the T-piece system being that it removed both the effect of either "too small a bag size" from limiting inflation time and overly large and cumbersome bag size affecting the seal with the mask. The method was equally successful to historical control infants resuscitated by bag.

More recently Allwood et al compared the outcome and rate of intubation of newborns resuscitated during two separate time periods: one using bag and mask and the other using a T-piece resuscitator {Allwood 2003}. The outcomes are difficult to interpret because of the use of historical controls and the possibility of other changes in practice during the study period. Fewer convulsions occurred in association with the use of the T-piece resuscitator even though the prevalence of meconium aspiration syndrome was stable during the two time periods. No complications resulting from the use of the T-piece resuscitator were identified when it was used for all resuscitations from a birth cohort of 8000 deliveries {Allwood 2003}. The T-piece resuscitator also was used without complication during the stabilization of 104 infants in the National Institute of Child Health and Human Development (NICHD) network pilot study of using continuous positive airway pressure (CPAP) and PEEP in resuscitation of infants less than 28 weeks' gestational age {Finer 2004}.

Conclusion

DISCLAIMER: Potential possible wording for a Consensus on Science Statement. Final wording will differ due to other input and discussion.

CONSENSUS ON SCIENCE:

- There are no clinical studies in newborns requiring positive pressure during resuscitation to support or refute superiority of the T-piece resuscitator over bag ventilation in improving outcome.
- In mechanical models, target inflation pressures are delivered more consistently when using T-piece resuscitators than with self-inflating bags. (LOE 5 - Hussey 2004, F490; Oddie 2005, 109; Finer 2001, 299)
- In mechanical models, PEEP is maintained more consistently with T-piece resuscitators compared with self-inflating bags. (LOE 5 - Finer 2001, 299)
- In mechanical models, the ability to deliver a sustained inflation is better with either a T-piece resuscitator or flow-inflating bag compared with a self-inflating bag. (LOE 5 - Bennett 2005, 113)

TREATMENT RECOMMENDATION:

KNOWLEDGE GAPS

- There are no RCT's comparing the performance of different devices during neonatal resuscitation.

Acknowledgements:

Citation List

Citation Marker	Full Citation*
Allwood 2003	Allwood AC, Madar RJ, Baumer JH, Readdy L, Wright D. Changes in resuscitation practice at birth. Arch Dis Child Fetal Neonatal Ed 2003;88(5):F375-9. AIM: To investigate secular changes in neonatal resuscitation at birth. METHODS: Single centre observational study of 17 890 infants born between May 1993 and April 1997. T-piece ventilation was introduced in April 1995. OBSERVATIONS: Rates and modes of ventilatory resuscitation, early neonatal encephalopathy, neonatal convulsions, and meconium aspiration syndrome; 1 and 5 min Apgar scores; maternal age and method of delivery; paediatric attendance at delivery and resuscitation. RESULTS: The rate of all forms of ventilatory resuscitation fell during the four year period from 11.0% to 8.9%. The rate of intubation fell from 2.4% to 1.2%. A reduced rate of intubation was seen at all gestations of 30 weeks and above. There was no difference in rates of relevant neonatal problems during the period except for a reduction in neonatal convulsions. The introduction of T-piece ventilation did not contribute to the reduction in intubation in a logistic regression model that included time trend. CONCLUSION: A marked reduction in the rate of intubation was observed, without any reduction in the efficacy of resuscitation. This may reflect improvements and changing emphasis in resuscitation training. **Comment:** Retrospective analysis of prospective clinical data. Historical control. Excellent quality. Compares bag and mask (period 1) to ventilation using the Neo- puff® (period 2). Even though the rates of early neonatal encephalopathy and meconium aspiration syndrome did not change significantly during the study period, the rate of neonatal convulsions fell by 78%. The reduction in the intubation rate at birth, particularly marked between 30 and 37 weeks' gestation, is not attributed exclusively to the introduction of the T piece. *LOE 3; neutral; fair*
Bennett 2005	Bennett S, Finer NN, Rich W, Vaucher Y. A comparison of three neonatal resuscitation devices. Resuscitation 2005;67(1):113-8. BACKGROUND: Ventilation during neonatal resuscitation involves the use of self-inflating bags, flow-inflating bags, and T-piece resuscitators. The ability of operators to deliver desired peak inspiratory pressures (PIP), positive end expiratory pressures (PEEP), prolonged inflations and the length of time to transition between different pressures has not been compared for all three of these devices. OBJECTIVE: To compare the ability of neonatal resuscitation personnel to deliver predetermined ventilation interventions using these devices in advance of a clinical trial of neonatal resuscitation. DESIGN/METHODS: We studied 31 operators (neomatologists, neonatal respiratory therapists, neonatal fellows, a pediatrician, pediatric residents, neonatal nurse practitioners, and neonatal nurses) using a T-piece resuscitator (Neopuff), Fisher and Paykel Healthcare, Auckland, New Zealand), a self-inflating bag (Baby Blue II, Vital Signs, Totowa, NJ), and a flow-inflating bag (Model E191 Anesthesia Associates, San Marcos, CA). The self-inflating bag was tested with and without the manufacturer's PEEP valve. Using a continuous pressure recording system and a neonatal manikin, we evaluated the ability to deliver a consistent PIP of 20 or 40 cmH2O and a PEEP of 5 cmH2O during 30 s of ventilation, the ability to maintain a 5 s inflation at a PIP of 20 cmH2O and the time to transition from a PIP of 20 to

	40 cmH2O. Each device was evaluated with and without a qualitative CO2 detector (Pedicap) Nellcor Pleasanton, CA). RESULTS: The T-piece resuscitator delivered the desired PIP more precisely and consistently compared with the self-inflating bag at a target of 20 cmH2O (maximum PIP 20.7 cmH2O, S.D.=0.8 versus 24.7 cmH2O, S.D.=2.8; p<0.001). At a target of 40 cmH2O, the maximum pressure delivered with the T-piece resuscitator was significantly less than both the flow-inflating bag and the self-inflating bag (39.7 cmH2O, S.D.=2.1 versus 44 cmH2O, S.D.=3.3 versus 45.3 cmH2O, S.D.=4.7; p<0.001). It took significantly longer to increase the PIP from 20 to 40 cmH2O using the T-piece resuscitator compared to the self-inflating bag or the flow-inflating bag (5.7 s versus 2.2 s versus 1.8 s; p<0.001), and three operators could not make the transition in the allotted 15 s time limit. During the 5 s prolonged inflation, the T-piece resuscitator and the flow-inflating bag maintained a pressure greater than 18 cmH2O for a longer time than the self-inflating bag (4 s versus 3.7 s versus 2.2 s; p<0.001). The self-inflating bag with the PEEP valve in place provided significantly less PEEP than both the T-piece resuscitator and the flow-inflating bag (3.6 cmH2O versus 4.4 cmH2O versus 4.4 cmH2O; p<0.005). The Pedicap did not significantly affect any of the observed results, and there were no consistent operator differences between different disciplines or years of experience. CONCLUSIONS: The T-piece resuscitator delivered the desired pressures more accurately, but required greater time to increase the PIP from 20 to 40 cmH2O. It was difficult to maintain a prolonged inflation and deliver the desired PEEP with the self-inflating bag even with the PEEP valve in place. There is a need for improvement in the design and function of current manual resuscitation devices and for prospective trials to evaluate the optimal method of bag and mask ventilation during resuscitation of the newborn infant. **Comment:** *LOE 5; supports; good*
Dawson 2007	Dawson JA, Davis PG, Kamlin CO, Morley CJ. Free-flow oxygen delivery using a T-piece resuscitator. Arch Dis Child Fetal Neonatal Ed 2007;92(5):F421. No Abstract **Comment:** Small study examining delivery of oxygen by T-piece resuscitator. No comparison group *LOE 5; neutral; fair*
Finer 2001	Finer NN, Rich W, Craft A, Henderson C. Comparison of methods of bag and mask ventilation for neonatal resuscitation. Resuscitation 2001;49(3):299-305. BACKGROUND: There are a variety of manual bagging devices used for neonatal resuscitation. To our knowledge, there has been no comparison of the ability of different operators to utilize such devices for the delivery of predetermined inspiratory and end-expiratory pressures. In addition, the use of prolonged inflation may be of benefit for infants who require bag and mask ventilation, and there has been no evaluation of the ability of a variety of operators to reliably deliver such breaths using currently available equipment. METHODS: We utilized a neonatal manikin (Laerdal Armonk, NY) with a functional larynx and lungs, and a clear cushioned mask (Owens-BriGam, Morganton, NC). We studied a latex-free disposable anesthesia type bag (Model 5126 Vital Signs, Totawa, NJ), a Jackson-Rees (JR) type anesthesia bag (Model E191 Anesthesia Associates, San Marcos, CA) fitted with a Norman elbow and a flow-control tail-piece (Dupaco, Oceanside, CA), and the Neopuff (Fisher and Paykel, Auckland, New Zealand), an FDA approved mechanical device that is flow-controlled and pressure-limited, specifically designed to facilitate neonatal resuscitation. The ventilating pressures were continuously recorded throughout the process. We evaluated neonatal nurses, neonatal nurse practitioners, neonatal staff and fellows, pediatric residents and neonatal respiratory therapists. RESULTS: The peak inspiratory pressure (PIP) was significantly different between operators using either anesthesia bag, P<0.001. Similar results were found for positive end-expiratory pressure (PEEP) with a significant difference among the operator groups, P<0.001. All the differences in post hoc analysis were between the therapists and

	the other groups, P<0.05. Therapists produced significantly higher pressures than the other groups for both PIP and PEEP (P<0.001). The PIP was similar for all groups using the Neopuff device. The PIP and PEEP delivered by the Neopuff differed from the other two devices independent of the operators (P<0.05). On post hoc analysis, there was a significant difference between the disposable anesthesia bag and Neopuff for both PIP and PEEP for the therapists, whereas among the non-therapists, there was a difference in PIP with the JR device producing a greater PIP (26.6+/-3.8 cmH(2)O) compared with the Neopuff and disposable anesthesia bag (24.8+/-1.1 cmH(2)O, 24.8+/-4.3 cmH(2)O). The level of PEEP was significantly different among all three devices for the non-therapists (1.3+/-1.6 cmH(2)O, Disposable; 2.9+/-1.2 cmH(2)O, JR; 4.7+/-0.5 cmH(2)O, Neopuff; P<0.05). Only the therapists were able to consistently deliver PEEP with the anesthesia bags, whereas all operators could generate the target PEEP with the Neopuff (P<0.05). We compared the pressure delivered during the first second to the pressure delivered during the fifth second during prolonged 5-s inflations. The absolute differences between the first and fifth second for the Neopuff versus the anesthesia bags were significantly different with a median of 7.1 cmH(2)O for the anesthesia bags compared with 0.2 cmH(2)O for the Neopuff, P<0.001, reflecting the difficulty in obtaining and maintaining the target inflation pressures. CONCLUSIONS: Our experience suggests that the Neopuff, a purpose-built neonatal resuscitator ventilator, facilitates the delivery of the desired airway pressures while maximizing the operator's ability to obtain and maintain a patent airway, and facilitates the delivery of prolonged inflations. Further research is required to determine the clinical benefit of end-expiratory pressure and prolonged inflations in neonatal resuscitation. **Comment:** A prospective, controlled study comparing two different flow-inflating bags with the Neopuff ™ device used by different health care workers using mannequins. There is no justification of the sample size provided. Many of the statements are based on beliefs and feelings. No description of how the staff was trained in the use of the Neopuff®. The discussion section is akin to a review article which goes beyond the scope of this study. *LOE 5; supports; fair*
Finer 2004	Finer NN, Carlo WA, Duara S, Fanaroff AA, Donovan EF, Wright LL, et al. Delivery room continuous positive airway pressure/positive end-expiratory pressure in extremely low birth weight infants: a feasibility trial. Pediatrics 2004;114(3):651-7. OBJECTIVE: Although earlier studies have suggested that early continuous airway positive pressure (CPAP) may be beneficial in reducing ventilator dependence and subsequent chronic lung disease in the extremely low birth weight (ELBW) infant, the time of initiation of CPAP has varied, and there are no prospective studies of infants who have received CPAP or positive end-expiratory pressure (PEEP) from initial resuscitation in the delivery room (DR). Current practice for the ELBW infant includes early intubation and the administration of prophylactic surfactant, often in the DR. The feasibility of initiating CPAP in the DR and continuing this therapy without intubation for surfactant has never been determined prospectively in a population of ELBW infants. This study was designed to determine the feasibility of randomizing ELBW infants of <28 weeks' gestation to CPAP/PEEP or no CPAP/PEEP during resuscitation immediately after delivery, avoiding routine DR intubation for surfactant administration, initiating CPAP on neonatal intensive care unit (NICU) admission, and assessing compliance with subsequent intubation criteria. METHODS: Infants who were of <28 weeks' gestation, who were born in 5 National Institute of Child Health and Human Development Neonatal Research Network NICUs from July 2002 to January 2003, and for whom a decision had been made to provide full treatment after birth were randomized to receive either CPAP/PEEP or not using a neonatal T-piece resuscitator (NeoPuff). Infants would not be intubated for the sole purpose of surfactant administration in the DR. After admission to the NICU, all nonintubated infants were placed on CPAP and were to be intubated for surfactant administration only after meeting specific criteria: a fraction of inspired oxygen of >0.3 with an oxygen saturation by pulse oximeter of <90% and/or an arterial oxygen pressure of <45 mm Hg, an arterial partial pressure of carbon dioxide of >55 mm Hg, or apnea requiring bag and mask ventilation. RESULTS: A total of 104 infants were enrolled over a 6-month

	period: 55 CPAP and 49 control infants. No infant was intubated in the DR for the exclusive purpose of surfactant administration. Forty-seven infants were intubated for resuscitation in the DR: 27 of 55 CPAP infants and 20 of 49 control infants. Only 4 of the 43 infants who had a birth weight of <700 g and 3 of the 37 infants of <25 weeks' gestation were resuscitated successfully without positive pressure ventilation, and no difference was observed between the treatment groups. All infants of 23 weeks' gestation required intubation in the DR, irrespective of treatment group, whereas only 3 (14%) of 21 infants of 27 weeks' required such intubation. For infants who were not intubated in the DR, 36 infants (16 CPAP infants and 20 control infants) were subsequently intubated in the NICU by day 7, in accordance with the protocol. Overall, 80% of studied infants required intubation within the first 7 days of life. The care provided for 52 (95%) of 55 CPAP infants and 43 (88%) of the 49 control infants was in compliance with the study protocol, with an overall compliance of 91%. CONCLUSIONS: This study demonstrated that infants could be randomized successfully to a DR intervention of CPAP/PEEP compared with no CPAP/PEEP, with intubation provided only for resuscitation indications, and subsequent intubation for prespecified criteria. Forty-five percent (47 of 104) of infants <28 weeks' gestation required intubation for resuscitation in the DR. CPAP/PEEP in the DR did not affect the need for intubation at birth or during the subsequent week. Overall, 20% of infants did not need intubation by 7 days of life. This experience should be helpful in facilitating the design of subsequent prospective studies of ventilatory support in ELBW infants. **Comment:** Feasibility study in which 104 ELBW infants were randomized to receive CPAP/PEEP or no CPAP/PEEP in the delivery room. CPAP/PEEP was delivered using a neonatal T-piece resuscitator. CPAP/PEEP in the DR did not affect intubation rates in ELBW infants. *LOE 4; neutral; fair*
Hawkes 2009a	Hawkes CP, Oni OA, Dempsey EM, Ryan CA. Potential hazard of the Neopuff T-piece resuscitator in the absence of flow limitation. Arch Dis Child Fetal Neonatal Ed 2009;94(6):F461-3. OBJECTIVE: (1) To assess peak inspiratory pressure (PIP), positive end expiratory pressure (PEEP) and maximum pressure relief (P(max)) at different rates of gas flow, when the Neopuff had been set to function at 5 l/min. (2) To assess maximum PIP and PEEP at a flow rate of 10 l/min with a simulated air leak of 50%. DESIGN: 5 Neopuffs were set to a PIP of 20, PEEP of 5 and P(max) of 30 cm H(2)O at a gas flow of 5 l/min. PIP, PEEP and P(max) were recorded at flow rates of 10, 15 l/min and maximum flow. Maximum achievable pressures at 10 l/min gas flow, with a 50% air leak, were measured. RESULTS: At gas flow of 15 l/min, mean PEEP increased to 20 (95% CI 20 to 21), PIP to 28 (95% CI 28 to 29) and the P(max) to 40 cm H(2)O (95% CI 38 to 42). At maximum flow (85 l/min) a PEEP of 71 (95% CI 51 to 91) and PIP of 92 cm H(2)O (95% CI 69 to 115) were generated. At 10 l/min flow, with an air leak of 50%, the maximum PEEP and PIP were 21 (95% CI 19 to 23) and 69 cm H(2)O (95% CI 66 to 71). CONCLUSIONS: The maximum pressure relief valve is overridden by increasing the rate of gas flow and potentially harmful PIP and PEEP can be generated. Even in the presence of a 50% gas leak, more than adequate pressures can be provided at 10 l/min gas flow. We recommend the limitation of gas flow to a rate of 10 l/min as an added safety mechanism for this device. **Comment:** Mechanical model evaluating of pressures generated by the T-piece resuscitator at various flow rates. *LOE 5; opposes; fair*
Hawkes 2009b	Hawkes CP, Oni OA, Dempsey EM, Ryan CA. Should the Neopuff T-piece resuscitator be restricted to frequent users? Acta Paediatr 2009. No abstract

	Comment: Brief communication describing assessment of 71 individuals including junior doctors, neonatal nurses, and midwives for their ability to setup the Neopuff device. Study demonstrated difficulty in setting up the device in the setting where regular training in its use was not provided. *LOE 5; opposes; poor*
Hoskyns 1987	Hoskyns EW, Milner AD, Hopkin IE. A simple method of face mask resuscitation at birth. Arch Dis Child 1987;62(4):376-8. Twenty two infants were resuscitated at birth using a face mask connected to an oxygen supply from a conventional resuscitaire. Intermittent finger occlusion provided the positive pressure within the mask. This method was apparently at least as effective as the best bag and mask systems and was convenient to use. **Comment:** A prospective in vivo study limited only to cesarean section babies. No strict selection criteria. Most babies cried before the episode of apnea. Study employed a T-piece resuscitator with a face mask for resuscitation. Used an initial prolonged inflation of 2-5 seconds. Adequate expiratory volumes were achieved with consistent inflation pressures of more than 25cm H2O. *LOE 4; supports; fair*
Hussey 2004	Hussey SG, Ryan CA, Murphy BP. Comparison of three manual ventilation devices using an intubated mannequin. Arch Dis Child Fetal Neonatal Ed 2004;89(6):F490-3. OBJECTIVE: To compare three devices for manual neonatal ventilation. DESIGN: Participants performed a two minute period of ventilation using a self inflating device, an anaesthesia bag with attached manometer, and a Neopuff device. An intubated neonatal mannequin, approximating a 1 kg infant with functional lungs, was used for the study. Target ventilation variables included a rate of 40 breaths per minute, peak inspiratory pressure (PIP) of 20 cm H2O, and positive end expiratory pressure (PEEP) of 4 cm H2O. The circuit was attached to a laptop computer for data recording. RESULTS: Thirty five participants were enrolled, including consultant neonatologists, paediatricians, and anaesthetists, paediatric and anaesthetic registrars, and neonatal nurses. The maximum PIP recorded using the self inflating bag, anaesthetic bag, and Neopuff device were 75.9, 35.5, and 22.4 cm H2O respectively. There were significant differences between the devices for mean PIP (30.7, 18.1, and 20.1 cm H2O), mean PEEP (0.2, 2.8, and 4.4 cm H2O), mean airway pressure (7.6, 8.5, and 10.9 cm H2O), % total breaths < or = 21 cm H2O PIP (39%, 92%, and 98%), and % total breaths > or = 30 cm H2O PIP (45%, 0, and 0). There was no difference between doctors and allied health professionals for the variables examined. CONCLUSION: The anaesthetic bag with manometer and Neopuff device both facilitate accurate and reproducible manual ventilation. Self inflating devices without modifications are not as consistent by comparison and should incorporate a manometer and a PEEP device, particularly when used for resuscitation of very low birthweight infants. **Comment:** *LOE 5; supports; fair*
Kattwinkel 2009	Kattwinkel J, Stewart C, Walsh B, Gurka M, Paget-Brown A. Responding to compliance changes in a lung model during manual ventilation: perhaps volume, rather than pressure, should be displayed. Pediatrics 2009;123(3):e465-70. OBJECTIVE: The standard technique for positive-pressure ventilation is to regulate the breath size by varying the pressure applied to the bag. Investigators have argued that consistency of peak inspiratory pressure is important. However, research shows that excessive tidal volume delivered with excessive pressure injures preterm lungs, which suggests that inspiratory pressure should be varied during times of changing compliance, such as resuscitation of newborns or treatment after surfactant delivery. METHODS: We

	modified a computerized lung model (ASL5000 [IngMar Medical, Pittsburgh, PA]) to simulate the functional residual capacity of a 3-kg neonate with apnea and programmed it to change compliance during ventilation. Forty-five professionals were blinded to randomized compliance changes while using a flow-inflating bag, a self-inflating bag, and a T-piece resuscitator. We instructed subjects to maintain a constant inflation volume, first while blinded to delivered volume and then with volume displayed, with all 3 devices. RESULTS: Subjects adapted to compliance changes by adjusting inflation pressure more effectively when delivered volume was displayed. When only pressure was displayed, sensing of compliance changes occurred only with the self-inflating bag. When volume was displayed, adjustments to compliance changes occurred with all 3 devices, although the self-inflating bag was superior. CONCLUSIONS: In this lung model, volume display permitted far better detection of compliance changes compared with display of only pressure. Devices for administration of positive-pressure ventilation should display volume rather than pressure. **Comment:** 45 Neonatology professionals were blinded to randomized compliance changes in a computerized test model using a flow-inflating bag, self-inflating bag, and T-piece resuscitator. Subjects were unable to detect compliance changes sufficiently to adjust pressures appropriately when only pressure was displayed, but performance improved significantly when volume was displayed. The performance using the self-inflating bag was superior for either pressure only or volume display conditions. *LOE 5; opposes; good*
Leone 2006	Leone TA, Rich W, Finer NN. A survey of delivery room resuscitation practices in the United States. Pediatrics 2006;117(2):e164-75. OBJECTIVE: To determine current resuscitation practices of neonatologists in the United States. METHODS: A 15-question survey was developed and mailed to neonatal directors in May 2004. RESULTS: Of the total of 797 surveys mailed, 84 were returned undeliverable or unanswered and 450 were returned completed (63% response rate). Respondents were mainly (70%) from level III NICUs. Most programs resuscitate newborns in the delivery room (83%), rather than in a separate room. The number and background of individuals attending deliveries vary greatly, with 31% of programs having <3 individuals attending deliveries. Flow-inflating bags are most commonly used (51%), followed by self-inflating bags (40%) and T-piece resuscitators (14%). Pulse oximeters are used during resuscitation by 52% of programs, and 23% of respondents indicated that there was a useful signal within 1 minute after application. Blenders are available for 42% of programs, of which 77% use pure oxygen for the initial resuscitation and 68% use oximeters to alter the fraction of inspired oxygen. Thirty-two percent of programs use carbon dioxide detectors to confirm intubation, 48% routinely and 43% when there is difficulty confirming intubation. Preterm infants are wrapped with plastic wrap to prevent heat loss in 29% of programs, of which 77% dry the infant before wrap application. A majority of programs (76%) attempt to provide continuous positive airway pressure or positive end expiratory pressure (PEEP) during resuscitation, most commonly with a flow-inflating bag (58%), followed by a self-inflating bag with PEEP valve (19%) and T-piece resuscitator (16%). A level of 5 cm H2O is used by 55% of programs. CONCLUSIONS: Substantial variations exist in neonatal resuscitation practices, some of which are not addressed in standard guidelines. Future guidelines should include recommendations regarding the use of blenders, oximeters, continuous positive airway pressure/PEEP, and plastic wrap during resuscitation. **Comment:** Survey of resuscitation practices in the United States. *LOE 5; neutral; fair*
McHale 2008	McHale S, Thomas M, Hayden E, Bergin K, McCallion N, Molloy EJ. Variation in inspiratory time and tidal volume with T-piece neonatal resuscitator: association with operator experience and distraction. Resuscitation 2008;79(2):230-3.

	The most recent Neonatal Resuscitation Programme (NRP 5th edition) guidelines recognise the T-piece resuscitator (Neopuff) device as an acceptable method of administering a pre-selected peak inspiratory pressure (PIP) and positive end expiratory pressure (PEEP). While these are constant, other parameters are operator-dependent. Although in widespread clinical use, there is little published data on the use of the T-piece resuscitator in neonatal resuscitation. This study showed that despite fixed inflating pressures, less experienced operators used prolonged inspiratory times. Wide variation in mean airway pressure and tidal volume were seen in all operators. **Comment:** *LOE 5; opposes; fair*
Milner 1984	Milner AD, Vyas H, Hopkin IE. Efficacy of facemask resuscitation at birth. Br Med J (Clin Res Ed) 1984;289(6458):1563-5. The efficacy of facemask resuscitation was assessed by measuring the expiratory tidal volume during the first three inflations in nine babies with birth asphyxia and comparing the results with those obtained in a further nine babies resuscitated after endotracheal intubation. The facemask system was relatively inefficient, with tidal exchange less than one third of that seen after intubation and rarely sufficient to produce adequate alveolar ventilation. Successful resuscitation depended on stimulating the baby to make his own respiratory efforts. **Comment:** Historical case controlled study comparing facemask resuscitation with endotracheal intubation. Peak inflation pressures similar between the two groups (range 24-36 cm H2O). The inefficiency of facemask ventilation was attributed to relatively short inspiratory time. *LOE 3; neutral; fair*
Morley 2009	Morley CJ, Dawson JA, Stewart MJ, Hussain F, Davis PG. The effect of a PEEP valve on a Laerdal neonatal self-inflating resuscitation bag. J Paediatr Child Health 2009. Background: Self-inflating bags are used to provide ventilation during neonatal resuscitation. However, they cannot provide positive end expiratory pressure (PEEP) unless a PEEP valve is attached. The ability of Laerdal neonatal self-inflating bags fitted with PEEP valves to reliably deliver PEEP is unclear. The aim of this study was to measure the delivered PEEP at different set PEEP levels and inflation rates. Methods: We connected disposable and non-disposable 240 mL Laerdal self-inflating resuscitation bags fitted with PEEP valves to a leak-free test lung. We measured PEEP delivered with the valve set at 5, 7 and 10 cm H(2)O whilst inflating the test lung at rates of 20, 40 and 60 min. Studies were done with 8 L/min of gas flow and with no gas flow. Results: The PEEP delivered was close to the set level immediately after inflation but declined rapidly between inflations. The mean PEEP was higher with faster ventilation rates. When PEEP was set at 7 cm H(2)O, using a non-disposable bag, and an inflation rate of 60/min the mean (SD) PEEP was 5.4 (0.19) cm H(2)O. The PEEP delivered was unrelated to the gas flow into the device. Conclusion: The 240 mL Laerdal self-inflating bag with a PEEP valve delivers PEEP that loses pressure quickly. The level of PEEP delivered is less than that set, particularly at rates below 40/min. **Comment:** *LOE 5; supports; fair*
Oddie 2005	Oddie, S., J. Wyllie, et al. (2005). "Use of self-inflating bags for neonatal resuscitation." Resuscitation **67**(1): 109-12. BACKGROUND: Lung inflation is the most important, and most difficult step in newborn resuscitation. A wide variety of devices are used to achieve lung inflation, but there are relatively few data to guide clinicians in their choice of device. METHODS: We tested the ability of instructors and trained candidates on a newborn life support course to deliver

	initial inflation breaths to a test lung, using a pressure limited blow-off valve, a 240-ml self-inflating bag and a 500-ml self-inflating bag in sequence. RESULTS: Use of a 240-ml self-inflating bag was associated with shorter initial inflations of 1.8 s mean (95% CI 1.60-1.99 s), compared with 2.42 s (2.24-2.61 s), 2.40 s (2.08-2.71 s) for 500-ml self-inflating bags and "Tom Thumb" T piece, respectively. Delivery of breaths within a target pressure range of 30+/-5 cm H2O was significantly better using a T piece than either self-inflating bag (proportion within target range 0.05 (95% CI 0-0.11), 0.17 (95% CI 0.12-0.23), 0.89 (95% CI 0.83-0.94) for 240-ml and 500-ml self-inflating bags and "Tom Thumb" T piece, respectively. Excessive pressure delivery with both sizes of self-inflating bag was frequent. CONCLUSIONS: These data do not support use of 240-ml or 500-ml self-inflating bags for resuscitation of newborn term infants. A variable pressure T piece blow-off system may be the easiest device to use for newborn resuscitation and the most reliable at delivering desired pressures for set times. **Comment:** *LOE 5; supports; good*
O'Donnell 2004a	O'Donnell CP, Davis PG, Morley CJ. Neonatal resuscitation: review of ventilation equipment and survey of practice in Australia and New Zealand. J Paediatr Child Health 2004;40(4):208-12. OBJECTIVE: The equipment used to provide positive pressure ventilation at neonatal resuscitation varies between institutions. Available devices were reviewed and their use surveyed in a geographically defined region. The aim of this study was to establish which resuscitation equipment is used at neonatal intensive care units in Australia and New Zealand. METHODS: A questionnaire was sent to a neonatologist at each of the 29 neonatal intensive care units in Australia and New Zealand, asking which resuscitation equipment they used. If it was not returned, follow up was by email and telephone. RESULTS: Data was obtained from all units. Round face masks are used at all centres. Anatomically shaped masks are infrequently used at two of the three centres (10%) that have them. Straight endotracheal tubes are used exclusively at 23 (79%) centres. Shouldered tubes are used infrequently at three of the six centres that have them. The Laerdal Infant Resuscitator self-inflating bag is used at 22 (76%) centres. Flow-inflating bags are used at 12 (41%) centres. The Neopuff Infant Resuscitator is used at 14 (48%) centres. Varying oxygen concentrations are provided at delivery at 6/25 (24%) centres. CONCLUSIONS: There is a paucity of evidence for the efficacy of the equipment used currently to resuscitate newborn infants. This complete survey of the tertiary centres in a geographical region shows considerable variation in practice, reflecting this lack of evidence and consequent uncertainty among clinicians. Further research is necessary to determine which devices are preferable for this most important and common intervention. **Comment:** Survey of resuscitation practices in Australia and New Zealand. *LOE 5; neutral; fair*
O'Donnell 2004b	O'Donnell CP, Davis PG, Morley CJ. Positive pressure ventilation at neonatal resuscitation: review of equipment and international survey of practice. Acta Paediatr 2004;93(5):583-8. BACKGROUND: The equipment used to provide positive pressure ventilation to newborns needing resuscitation at delivery varies between institutions. Devices were reviewed and their use surveyed in a sample of neonatal centres worldwide. AIM: To determine which equipment is used to resuscitate newborns at delivery in a sample of teaching hospitals around the world. METHODS: A questionnaire was sent via e-mail to a neonatologist at each of 46 NICUs in 23 countries on five continents, asking which resuscitation equipment they used. If it was not returned, follow-up was by e-mail. RESULTS: Data were obtained from 40 (87%) centres representing 19 countries. Round face masks are used at 34 (85%) centres, anatomically shaped masks are used exclusively at six (15%) and a mixture of types are used at 11 (28%). Straight endotracheal tubes are used exclusively at 36 (90%) centres: shouldered tubes are used infrequently at three of the four centres that have

	them. The self-inflating bag is the most commonly used manual ventilation device (used at 33 (83%) centres), the Laerdal Infant Resuscitator the most popular model. Flow-inflating bags are used at 10 (25%) centres. The Neopuff Infant Resuscitator is used at 12 (30%) centres. Varying oxygen concentrations are provided during neonatal resuscitation at half of the centres, while 100% oxygen is routinely used at the other half. CONCLUSIONS: This survey shows considerable variation in practice, reflecting this lack of evidence and consequent uncertainty among clinicians. Comparison of the two most popular manual ventilation devices, the Laerdal Infant Resuscitator and the Neopuff Infant Resuscitator, is urgently required. **Comment:** Survey of international resuscitation practices. *LOE 5; neutral; fair*
O'Donnell 2005a	O'Donnell, C. P., P. G. Davis, et al. (2005). "Neonatal resuscitation 2: an evaluation of manual ventilation devices and face masks." Arch Dis Child Fetal Neonatal Ed **90**(5): F392-6. BACKGROUND: The key to successful neonatal resuscitation is effective ventilation. Little evidence exists to guide clinicians in their choice of manual ventilation device or face mask. The expiratory tidal volume measured at the mask (V(TE(mask))) is a good estimate of the tidal volume delivered during simulated neonatal resuscitation. AIM: To compare the efficacy of (a) the Laerdal infant resuscitator and the Neopuff infant resuscitator, used with (b) round and anatomically shaped masks in a model of neonatal resuscitation. METHODS: Thirty four participants gave positive pressure ventilation to a mannequin at specified pressures with each of the four device-mask combinations. Flow, inspiratory tidal volume at the face mask (V(TI(mask))), V(TE(mask)), and airway pressure were recorded. Leakage from the mask was calculated from V(TI(mask)) and V(TE(mask)). RESULTS: A total of 10,780 inflations were recorded and analysed. Peak inspiratory pressure targets were achieved equally with the Laerdal and Neopuff resuscitators. Positive end expiratory pressure was delivered with the Neopuff but not the Laerdal device. Despite similar peak pressures, V(TE(mask)) varied widely. Mask leakage was large for each combination of device and mask. There were no differences between the masks. CONCLUSION: During face mask ventilation of a neonatal resuscitation mannequin, there are large leaks around the face mask. Airway pressure is a poor proxy for volume delivered during positive pressure ventilation through a mask. **Comment:** *LOE 5; supports; fair*
O'Donnell 2005b	O'Donnell, C. P., P. G. Davis, et al. (2005). "Neonatal resuscitation 3: manometer use in a model of face mask ventilation." Arch Dis Child Fetal Neonatal Ed **90**(5): F397-400. BACKGROUND: Adequate ventilation is the key to successful neonatal resuscitation. Positive pressure ventilation (PPV) is initiated with manual ventilation devices via face masks. These devices may be used with a manometer to measure airway pressures delivered. The expiratory tidal volume measured at the mask (V(TE(mask))) is a good estimate of the tidal volume delivered during simulated neonatal resuscitation. AIM: To assess the effect of viewing a manometer on the peak inspiratory pressures used, the volume delivered, and leakage from the face mask during PPV with two manual ventilation devices in a model of neonatal resuscitation. METHODS: Participants gave PPV to a modified resuscitation mannequin using a Laerdal infant resuscitator and a Neopuff infant resuscitator at specified pressures ensuring adequate chest wall excursion. Each participant gave PPV to the mannequin with each device twice, viewing the manometer on one occasion and unable to see the manometer on the other. Data from participants were averaged for each device used with the manometer and without the manometer separately. RESULTS: A total of 7767 inflations delivered by the 18 participants were recorded and analysed. Peak inspiratory pressures delivered were lower with the Laerdal device. There were no differences in leakage from the face mask or volumes delivered. Whether or not the manometer was visible made no difference to any measured variable.

	CONCLUSIONS: Viewing a manometer during PPV in this model of neonatal resuscitation does not affect the airway pressure or tidal volumes delivered or the degree of leakage from the face mask. **Comment:** *LOE 5; supports; fair*
Reise 2009	Reise K, Monkman S, Kirpalani H. The use of the Laerdal infant resuscitator results in the delivery of high oxygen fractions in the absence of a blender. Resuscitation 2009;80(1):120-5. BACKGROUND: High oxygen increases morbidity and mortality. Current guidelines in Neonatal Resuscitation Programme (NRP) state if self-inflating bags are used with an input FiO2 of 1.0 without an oxygen reservoir a delivered safe FiO2 of approximately 0.40 is achieved. This conflicts with manufacturer findings (Laerdal infant resuscitator (LIR)). We assessed FiO2 delivery by the LIR, varying oxygen reservoir (OR) use, ventilation and input flowrates. METHODS: A test lung was connected to the LIR and oxygen analyzer. FiO2 delivery was measured under these four conditions: LIR plus OR and FiO2 1.0 or FiO2 0.40; LIR minus OR and FiO2 of 1.0 and 0.40. Variations of ventilation patterns in random order, assessed tidal volumes (from 20 and 40mL), ventilation rates (from 30, 40 and 60breaths/min), and input flowrates (from 1, 3, 5, 8, and 10Lpm). A wash-out period of 1min of ventilation was followed by measure of FiO2 during manual ventilation. RESULTS: The measured FiO2 with the LIR delivered the same source FiO2 under all experimental conditions for flowrates of 5Lpm and greater; irrespective of the OR presence or absence. At flowrates of 1 and 3Lpm, FiO2 was lower, with and without the reservoir, but the reservoir was visibly identified as not filled. CONCLUSION: Our findings support the manufacturers performance specification that high input FiO2 results in high delivered FiO2 with/without an OR. These results dispute the 2006 NRP guidelines that state "in the absence of a reservoir (oxygen) the delivered oxygen is reduced to about 40%". **Comment:** *LOE 5; neutral; good*
Vyas 1981	Vyas, H., A. D. Milner, et al. (1981). "Physiologic responses to prolonged and slow-rise inflation in the resuscitation of the asphyxiated newborn infant." J Pediatr **99**(4): 635-9. Measurements of thoracic volume, inflation pressure, and intrathoracic pressure have been recorded at the resuscitation of nine newborn babies. The initial inflation pressure was maintained for approximately five seconds which produced a twofold increase in inflation volume compared to standard resuscitation techniques and always led to formation of an FRC. When the inflation pressure was increased slowly over three to five seconds, the apparent opening pressure which occurred universally in square wave inflation was rarely seen. **Comment:** Series of nine patients in which prolonged inflation, with peak pressure set at 30 cm H2O, either by “square wave“ maintained for 5 seconds or by “slow-rise inflation” resulted in an increase in tidal volume when compared with previously published data. No controls in the present study. Initial breath only given for 5 seconds. Subsequent breaths with an inspiratory time of 1 second. *LOE 4; supports; fair*
Wood 2008a	Wood FE, Morley CJ, Dawson JA, Kamlin CO, Owen LS, Donath S, et al. Assessing the effectiveness of two round neonatal resuscitation masks: study 1. Arch Dis Child Fetal Neonatal Ed 2008;93(3):F235-7. BACKGROUND: Positive pressure ventilation (PPV) via a face mask is an important skill taught using manikins. There have been few attempts to assess the effectiveness of different face mask designs. AIM: To determine whether leak at the face mask during simulated neonatal resuscitation differed between a new round mask design and the

	current most widely used model. METHOD: 50 participants gave PPV to a modified manikin designed to measure leak at the face mask. Leak was calculated from the difference between the inspired and expired tidal volumes. RESULTS: Mask leak varied widely with no significant difference between devices; mean (SD) percentage leak for the Laerdal round mask was 55% (31) and with the Fisher & Paykel mask it was 57% (25). CONCLUSION: We compared a new neonatal face mask with an established design and found no difference in leak. On average the mask leak was >50% irrespective of operator experience or technique. **Comment:** Evaluation of mask leak by mask type using the T-piece resuscitator *LOE 5; neutral; fair*
Wood 2008b	Wood FE, Morley CJ, Dawson JA, Kamlin CO, Owen LS, Donath S, et al. Improved techniques reduce face mask leak during simulated neonatal resuscitation: study 2. Arch Dis Child Fetal Neonatal Ed 2008;93(3):F230-4. BACKGROUND: Techniques of positioning and holding neonatal face masks vary. Studies have shown that leak at the face mask is common and often substantial irrespective of operator experience. AIMS: (1) To identify a technique for face mask placement and hold which will minimise mask leak. (2) To investigate the effect of written instruction and demonstration of the identified technique on mask leak for two round face masks. METHOD: Three experienced neonatologists compared methods of placing and holding face masks to minimise the leak for Fisher & Paykel 60 mm and Laerdal size 0/1 masks. 50 clinical staff gave positive pressure ventilation to a modified manikin designed to measure leak at the face mask. They were provided with written instructions on how to position and hold each mask and then received a demonstration. Face mask leak was measured after each teaching intervention. RESULTS: A technique of positioning and holding the face masks was identified which minimised leak. The mean (SD) mask leaks before instruction, after instruction and after demonstration were 55% (31), 49% (30), 33% (26) for the Laerdal mask and 57% (25), 47% (28), 32% (30) for the Fisher & Paykel mask. There was no significant difference in mask leak between the two masks. Written instruction alone reduced leak by 8.8% (CI 1.4% to 16.2%) for either mask; when combined with a demonstration mask leak was reduced by 24.1% (CI 16.4% to 31.8%). CONCLUSION: Written instruction and demonstration of the identified optimal technique resulted in significantly reduced face mask leak. **Comment:** Evaluation of mask leak during simulated resuscitation using the T-piece resuscitator before and after subjects received written instructions and demonstration of technique of positioning and holding the face mask. *LOE 5; neutral; fair*
Wood 2008c	Wood FE, Morley CJ, Dawson JA, Davis PG. A respiratory function monitor improves mask ventilation. Arch Dis Child Fetal Neonatal Ed 2008;93(5):F380-1. This study investigated whether the use of a respiratory monitor during simulated neonatal resuscitation reduced leak at the face mask. It showed the leak was more than halved, being reduced from 27% to 11% when 25 participants used the monitor to identify and correct the mask leak. **Comment:** Evaluation of mask leak during simulated resuscitation using the T-piece resuscitator using a respiratory function monitor. *LOE 5; neutral; fair*

*Type the citation marker in the first field and then paste the full citation into the second field. You can copy the full citation from EndNote by selecting the citation, then copying the FORMATTED citation using the short cut, Ctrl-K. After you copy the

citation, go back to this document and position the cursor in the field, then paste the citation into the document (use Ctrl-V). For each new citation press Enter to move down to start a new paragraph.