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

Worksheet author

Colin A Graham	**Date Submitted for review:** 31 December 2009

Clinical question

In adult and pediatric patients in cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) who are NOT endotracheally intubated (P), does providing ventilation with a 1 second inspiratory time and tidal volume of about 600 mL (I), compared with other inspiratory times and tidal volume (C), improve any outcomes (including ventilation, oxygenation) (O)?

Is this question addressing an intervention/therapy, prognosis or diagnosis? Intervention/therapy (tidal volume/inspiratory time)
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 conflict of interest.

Search strategy (including electronic databases searched)

Database: All EBM Reviews - Cochrane DSR, ACP Journal Club, DARE, CCTR, CMR, HTA, and NHSEED Search Strategy:
1 exp heart arrest/ (738)
2 exp cardiopulmonary resuscitation/ (326)
3 ventilation.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] (8538)
4 bag-valve-mask.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] (35)
5 artificial respiration.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] (26)
6 assisted ventilation.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] (357)
7 manual ventilation.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] (47)
8 tidal volume.mp. [mp=ti, ot, ab, tx, kw, ct, sh, hw] (1270)
9 (1 or 2) and (3 or 4 or 5 or 6 or 7 or 8) (89)

4 potentially relevant studies identified from 89 possible papers; 2 papers finally relevant to the question.

MEDLINE (via OVID SP): Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) <1950 to Present> Search Strategy:
1 exp heart arrest/ (25324)
2 exp cardiopulmonary resuscitation/ (7526)
3 exp Intermittent Positive-Pressure Ventilation/ or exp Ventilation/ or ventilation.mp. or exp Pulmonary Ventilation/ (98645)
4 artificial respiration.mp. or exp Respiration, Artificial/ (48175)
5 exp Respiration, Artificial/ or exp Positive-Pressure Respiration/ or assisted ventilation.mp. (48591)
6 exp Respiration, Artificial/ or manual ventilation.mp. or exp Positive-Pressure Respiration/ (47755)
7 tidal volume.mp. or exp Tidal Volume/ (11725)
8 exp Respiration, Artificial/ or exp Masks/ or bag-valve-mask.mp. or exp Resuscitation/ (80053)
9 (1 or 2) and (3 or 4 or 5 or 6 or 8) and 7 (148)

24 potentially relevant papers found from 149 possible papers; 2 papers finally relevant to the question in addition to the 2 above (total 4).

EMBASE (via OVID SP): Database: EMBASE <1980 to 2009 May 29> Search Strategy:
1 exp heart arrest/ (16339)
2 exp cardiopulmonary resuscitation/ (24914)
3 exp Intermittent Positive-Pressure Ventilation/ or exp Ventilation/ or ventilation.mp. or exp Pulmonary Ventilation/ (84755)
4 artificial respiration.mp. or exp Respiration, Artificial/ (55116)
5 exp Respiration, Artificial/ or exp Positive-Pressure Respiration/ or assisted ventilation.mp. (59865)
6 exp Respiration, Artificial/ or manual ventilation.mp. or exp Positive-Pressure Respiration/ (54980)
7 tidal volume.mp. or exp Tidal Volume/ (9716)
8 exp Respiration, Artificial/ or exp Masks/ or bag-valve-mask.mp. or exp Resuscitation/ (82306)
9 (1 or 2) and (3 or 4 or 5 or 6 or 8) and 7 (274)

30 potentially relevant papers from 274 possible papers; 4 papers finally relevant to the question in addition to 3 of the the 4 above (total 8).

AHA Endnote Master Database – ['Heart arrest' OR 'cardiopulmonary resuscitation'] AND 'ventilation' as word in any field AND 'tidal volume' as word in any field – 11 potentially relevant papers from 45 possible papers; no additional papers to those already found.

Review of references from papers/studies retrieved – no further studies identified.

• State inclusion and exclusion criteria

Include all studies where there was a comparison of 600mL [~500-700mL] tidal volumes (with approximately one second inspiratory time) with any other ventilation mode during cardiopulmonary resuscitation AND an identifiable result showing that reported clinical outcomes (return of spontaneous circulation, survival to discharge from hospital, oxygenation status, ventilation status, incidence of aspiration).

Exclude all neonatal and infant studies and those studies involving patients or animals that were intubated. Exclude studies where no clinically relevant outcomes were reported. Exclude review articles.

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

8 articles: 1 LOE4; 7 LOE5.

Summary of evidence

Evidence Supporting Clinical Question

Good					Wenzel 1999 25 E
Fair					Dorges 2000 195 E Dorges 2000 37 E
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					Stallinger 2001 1265 E
Fair					
Poor					Von Goedecke 2005 321 E Von Goedecke 2005 117 E Von Goedecke 2006 629 E
	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					
Fair				Pytte M 2008 35 E	
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

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

Wenzel (1999 25) demonstrates clearly that a small tidal volume ventilation strategy using a 750mL paediatric bag valve mask device supplemented by 50% oxygen causes less gastric insufflation and similar levels of oxygenation. Dorges (2000 195) suggests that oxygenation and carbon dioxide elimination can be maintained with 1100mL bag valve mask devices using room air (tidal volume 624mL) but his next study (2000 37) confirmed that with room air, a paediatric bag valve mask device (700mL capacity, tidal volume 455mL) was not sufficient to maintain oxygenation, but the adult bag valve mask (1500mL capacity, tidal volume 719mL) was able to do so. However, all these studies were performed in anaesthetised patients, not patients in cardiac arrest, which limits their applicability to the cardiac arrest situation under consideration.

Stallinger (2001 1265) conducted a high quality study but its applicability to the cardiac arrest situation is limited and mixed results were found; 500mL tidal volumes with room air gave acceptable blood gases, whereas 1000mL tidal volumes were required if expired air resuscitation was used. It is unknown how this would extrapolate to cardiac arrest patients in the real-life situation. Von Goedecke (2005 321; 2005 117; 2006 629) demonstrated in various mechanical models the relative equivalence in tidal volume terms of a 1s inspiratory time and a 2s inspiratory time. The small study by Pytte (2008 35) suggests that real-life blood gases after basic life support ventilation using mouth-to-mask ventilation may be poorer than other studies suggest, but care must be taken not to extrapolate too much from this tiny dataset.

Acknowledgements: Nil

Citation List

Dorges V, Ocker H, Hagelberg S, Wenzel V, Schmucker P. Resuscitation. 2000;43(3):195-199. Optimisation of tidal volumes given with self-inflatable bags without additional oxygen.

Level 5. Fair quality, supports clinical question (prospective clinical study in anaesthetised patients, not in cardiac arrest, reasonable numbers, n=50). Two blocks of 25 ASA I & II patients each, block randomized. No preoxygenation prior to induction of anaesthesia. After induction, manual ventilation performed with either 1500mL capacity bag valve mask device or 1100mL capacity bag valve mask device with room air for 5 minutes before intubation. No preset minute ventilation or tidal volume for study. Tidal volumes less in 1100mL bag group (624mL v 738mL) as was SaO_2 (95% v 96%) and PaO_2 (78mmHg v 87mmHg). $PaCO_2$ was the same for both groups (37mmHg). Gastric inflation not assessed. Work was supported by local research funds, no industry funding noted.
[EMBASE]

Dorges V, Ocker H, Hagelberg SO, Wenzel V, Idris AH, Schmucker P. Resuscitation. 2000;44(1):37-41. Smaller tidal volumes with room-air are not sufficient to ensure adequate oxygenation during bag-valve-mask ventilation.

Level 5. Fair quality, supports clinical question (prospective clinical study in anaesthetised patients, not in cardiac arrest, reasonable numbers, n=40). Two blocks of 20 ASA I & II patients each, block randomized. No preoxygenation prior to induction of anaesthesia. After induction, manual ventilation performed with either 1500mL capacity adult bag valve mask device or 700mL capacity paediatric bag valve mask device with room air for 5 minutes before intubation. No preset tidal volume for study. Respiratory rate set at 15/minute. In the 700mL paediatric bag group tidal volumes were less (455mL v 719mL, $p<0.0001$) as was SaO_2 (93% v 96%, $p<0.01$) and PaO_2 (73mmHg v 87mmHg, $p<0.01$), and $PaCO_2$ was higher (40mmHg v 37mmHg, $p<0.05$). In 3 of 20 patients in the 700mL paediatric bag group, SaO_2 fell below 90% and the study was terminated in those patients. Gastric inflation not assessed. Work was supported by local research funds, no industry funding noted.
[EMBASE]

Pytte M, Dorph E, Sunde K, Kramer-Johansen J, Wik L, Steen PA. Resuscitation. 2008;77(1):35-8. Arterial blood gases during basic life support of human cardiac arrest victims.

Level 4. Fair quality, opposes clinical question (prospective human out-of-hospital study, small numbers, n=8, only 4 had mouth-to-mask ventilation). Basic life support re-established after death declared following prolonged out-of-hospital arrest. Tidal volumes not measured for mouth-to-mask ventilation but 'chest rise only' so likely to be around 500-600mL. After 7-8 minutes of mouth-to-mask ventilation (n=4), mean $PaCO_2$ was 10.65 kPa and mean PaO_2 was 8.4 kPa. Likely to be biased by prolonged arrest time so results may not reflect the effect of mouth-to-mask ventilation at the onset of cardiac arrest. Funded by local hospital and health authority funds, the Norwegian Air Ambulance Foundation, the Laerdal Acute Medicine Foundation and the Andre Jahres Fund. One author is a member of a medical advisory board for PhysioControl and a consultant for Laerdal and Jolife. Another author is a member of the board of Laerdal and the Norwegian Air Ambulance.
[MEDLINE] [EMBASE]

Stallinger A, Wenzel V, Oroszy S, Mayr VD, Idris AH, Lindner KH, Hormann C. Anesthesia and Analgesia. 2001;93(5):1265-9. The effects of different mouth-to-mouth ventilation tidal volumes on gas exchange during simulated rescue breathing.

Level 5. Good quality, neutral to clinical question (prospective randomised human study, small numbers, n=20 x3 repeated measures). Randomised volunteer trial examining 500mL v 1000mL tidal volumes of expired air mix compared to 500mL tidal volume of room air.

Volunteers and data recording investigator blinded to gas used. Spontaneous breathing throughout, not anaesthetised. 500mL tidal volumes of expired air mix associated with hypoxia and hypercarbia compared to 1000mL tidal volume of expired air or 500mL tidal volume of room air. Funded by research grant from the Austrian Science Foundation and a Founders Grant of the Society for Critical Care Medicine.
[EBMR & CCRCT] [MEDLINE] [EMBASE]

Von Goedecke A, Bowden K, Keller C, Voelckel WG, Jeske H-C, Wenzel V. Anaesthesist. 2005;54(2):117-122. Decreased inspiratory time during ventilation of an unprotected airway: Effect on stomach inflation and lung ventilation in a bench model.

Level 5. Poor quality, neutral to clinical question (mechanical model study, unknown numbers, probably small). Mechanical model study shows comparable tidal volumes (380mL to 630mL) generated whether a 1s or 2s inspiratory time is used. Unknown funding. One of the authors works for O-Two Medical Technology, a company which manufactures and develops bag valve mask devices – possible conflict of interest.
[EMBASE]

Von Goedecke A, Bowden K, Wenzel V, Keller C, Gabrielli A. Resuscitation. 2005;64(3):321-5. Effects of decreasing inspiratory times during simulated bag-valve-mask ventilation.

Level 5. Poor quality, neutral to clinical question (mechanical model study, unknown numbers, probably small). Mechanical model study shows comparable tidal volumes (around 540mL to 870mL) generated whether a 1s or 2s inspiratory time is used. Funded by research grant from the Austrian National Bank Project and the Austrian Science Foundation. One of the authors works for O-Two Medical Technology, a company which manufactures and develops bag valve mask devices – possible conflict of interest.
[MEDLINE]

Von Goedecke A, Paal P, Keller C, Voelckel WG, Herff H, Lindner KH, Wenzel V. Anaesthesist. 2006;55(6):629-634. Ventilation of an unprotected airway. Evaluation of a new peak-inspiratory-flow and airway-pressure-limiting bag-valve-mask.

Level 5. Poor quality, neutral to clinical question (mechanical model study, unknown numbers, probably small). Mechanical model study shows decreased but clinically comparable tidal volumes generated using the Smart-Bag device when a 1s inspiratory time is compared to 2s. Unknown funding.
[EMBASE]

Wenzel V, Keller C, Idris AH, Dorges V, Lindner KH, Brimacombe JR. Resuscitation. 1999;43(1):25-9. Effects of smaller tidal volumes during basic life support ventilation in patients with respiratory arrest: good ventilation, less risk?

Level 5. Good quality, supports clinical question (prospective randomised clinical study in anaesthetised patients, not in cardiac arrest, good numbers, n=80). 40 ASA I & II patients in each group, randomized to ventilation with adult or paediatric bag valve mask device. No preoxygenation prior to induction of anaesthesia. After induction, manual ventilation performed with either 1500mL capacity adult bag valve mask device or 750mL capacity paediatric bag valve mask device with 50% inspired oxygen for 3 minutes before laryngeal mask placement. No preset minute ventilation or tidal volume for study. Anaesthesiologists blinded to all monitoring, and investigator performing auscultation for gastric air entry was also blinded. Tidal volumes less in 750mL bag group (365mL v 779mL, $p<0.0001$) as was SaO_2 (97% v 98%, NS). End tidal CO_2 was higher in the paediatric bag group (33 v 26mmHg, $p<0.0001$). Gastric inflation occurred in 5 of the adult bag cases but none in the paediatric group. Work was supported by local research funds and the Laerdal Foundation for Acute Medicine.

[EBMR & CCRCT] [MEDLINE] [EMBASE]

EBM & CCRCT: EBM Reviews - Cochrane Central Register of Controlled Trials