

Bag Valve Mask (BVM) Research Studies

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Ir Med J 2000 Mar-Apr;93(2):55-7

1 Effectiveness of mask ventilation performed by hospital doctors in an Irish tertiary referral teaching hospital.

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The objective of this study was to assess the effectiveness of mask ventilation performed by 112 doctors with clinical responsibilities at a tertiary referral teaching hospital.

Participant doctors were asked to perform mask ventilation for three minutes on a Resusci Anne mannequin using a facemask and a two litre self inflating bag. The tidal volumes generated were quantified using a Laerdal skillmeter computer as grades 0-5, corresponding to 0, 334, 434, 561, 673 and > 800 ml respectively.

The effectiveness of mask ventilation (i.e. the proportion of ventilation attempts which achieved a volume delivery of > 434 mls) was greater for anaesthetists [78.0 (29.5)%] than for non anaesthetists [54.6 (40.0)%] ($P = 0.012$).

Doctors who had attended one or more resuscitation courses were no more effective at mask ventilation than their colleagues who had not undertaken such courses. It is likely that first responders to in-hospital cardiac arrests are commonly unable to perform adequate mask ventilation.

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Resuscitation 2000 Oct 1;47(2):175-178

2 Ventilation volumes with different self-inflating bags with reference to the ERC guidelines for airway management: comparison of two compression techniques.

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The 1998 ERC-guidelines for airway-management recommend an tidal volume of 400-600 ml for adults undergoing CPR. As commercially available self-inflating bags were designed to meet former recommendations (800-1200 ml) we investigated how to meet the latest recommendations with these bags.

We combined the head of a training manikin (Laerdal Medical) and a standard lung (VTTL; Michigan Instrument), adjusted to a physiological compliance and resistance. Volume was measured with a Wright spirometer (BOC). Seven self-inflating bags were investigated. Tests were carried out by ten people (five female and five male) for 5 min each using two different techniques.

Technique 1: Standard ventilation with one hand without compression of the self-inflating bag against the rescuers knee.

Technique 2: Modified open palm technique with total squeezing of the self-inflating bag by compression against the rescuers knee. The average tidal volumes for technique 1 ranged from 438 to 604 ml. Applying technique 2 the volumes ranged from 888 to 1192 ml.

The latest recommendations were met using a single hand technique without compression against the rescuers knee for all seven bags tested. The modified open palm technique produced larger tidal volumes which were more in line with previous recommendations.

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Resuscitation 2000 Feb;43(3):195-9

3 Optimisation of tidal volumes given with self-inflatable bags without additional oxygen.

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The European Resuscitation Council has recommended smaller tidal volumes of 500 ml during basic life support ventilation in order to minimise gastric inflation. One method of delivering these tidal volumes may be to use paediatric instead of adult self-inflatable bags; however, we have demonstrated in other studies that only 350 ml may be delivered, using this technique.

The reduced risk of gastric inflation was offset by oxygenation problems, rendering the strategy of attempting to deliver tidal volumes of 500 ml with a paediatric self-inflatable bag questionable, at least when using room-air.

In this report, we assessed the effects of a self-inflatable bag with a size between the maximum size of a paediatric (700 ml) and an adult (1500 ml) self-inflatable bag on respiratory variables and blood gases during bag-valve-mask ventilation. After induction of anaesthesia, 50 patients were block-randomised into two groups of 25 each.

They were ventilated with room-air with either an adult (maximum volume, 1500 ml) or a newly developed medium-size (maximum volume, 1100 ml; Drager, Lubeck, Germany) self-inflatable bag for 5 min before intubation.

When compared with the adult self-inflatable bag, the medium-size bag resulted in significantly lower exhaled tidal volumes and tidal volumes per kg bodyweight (624 + 24 versus 738 +/- 20 ml, and 8.5 +/- 0.3 versus 10.7 +/- 0.3 ml kg⁻¹), respectively; P < 0.001), oxygen saturation (95 +/- 0.4 versus 96 +/- 0.3%; P < 0.05), and partial pressure of oxygen (78 +/- 3 versus 87 +/- 3 mmHg; P < 0.05).

Carbon dioxide levels were comparable (37 +/- 1 versus 37 +/- 1 mmHg). Our results indicate that smaller tidal volumes of about 8 ml x kg⁻¹ (approximately 600 ml), given with a new medium-size self-inflatable bag and room-air, maintained adequate carbon dioxide elimination and oxygenation during bag-valve-mask ventilation.

Accordingly, the new medium-size self-inflatable bag may combine both adequate ventilatory support and reduced risk of gastric inflation during bag-valve-mask ventilation.

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Resuscitation 2000 Mar;44(1):37-41

4 Smaller tidal volumes with room-air are not sufficient to ensure adequate oxygenation during bag-valve-mask ventilation.

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The European Resuscitation Council has recommended decreasing tidal volume during basic life support ventilation from 800 to 1200 ml, as recommended by the American Heart Association, to 500 ml in order to minimise stomach inflation.

However, if oxygen is not available at the scene of an emergency, and small tidal volumes are given during basic life support ventilation with a paediatric self-inflatable bag and room-air (21% oxygen), insufficient oxygenation and/or inadequate ventilation may result.

When apnoea occurred after induction of anaesthesia, 40 patients were randomly allocated to room-air ventilation with either an adult (maximum volume, 1500 ml) or paediatric (maximum volume, 700 ml) self-inflatable bag for 5 min before intubation. When using an adult (n=20) versus paediatric (n=20) self-inflatable bag, mean +/- SEM tidal volumes and tidal volumes per kilogram were significantly ($P < 0.0001$) larger (719 ± 22 vs. 455 ± 23 ml and 10.5 ± 0.4 vs. 6.2 ± 0.4 ml kg^{-1}), respectively).

Compared with an adult self-inflatable bag, bag-valve-mask ventilation with room-air using a paediatric self-inflatable bag resulted in significantly ($P < 0.01$) lower paO_2 values (73 ± 4 vs. 87 ± 4 mmHg), but comparable carbon dioxide elimination (40 ± 2 vs. 37 ± 1 mmHg; NS).

In conclusion, our results indicate that smaller tidal volumes of approximately 6 ml kg^{-1} (approximately 500 ml) given with a paediatric self-inflatable bag and room-air maintain adequate carbon dioxide elimination, but do not result in sufficient oxygenation during bag-valve-mask ventilation.

Thus, if small (6 ml kg^{-1}) tidal volumes are being used during bag-valve-mask ventilation, additional oxygen is necessary. Accordingly, when additional oxygen during bag-valve-mask ventilation is not available, only large tidal volumes of approximately 11 ml kg^{-1} were able to maintain both sufficient oxygenation and carbon dioxide elimination.

Bag Valve Mask (BVM) Research Studies

Resuscitation 1999 Dec;43(1):31-7

5 Smaller tidal volumes during cardiopulmonary resuscitation: comparison of adult and paediatric self-inflatable bags with three different ventilatory devices.

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Gastric inflation and subsequent regurgitation of stomach contents is a major hazard of bag-valve-face mask ventilation during the basic life support phase of cardiopulmonary resuscitation (CPR).

Recent investigations suggested that use of a paediatric self-inflating bag may reduce stomach inflation while ensuring sufficient lung ventilation. The purpose of our study was to examine whether use of a paediatric self-inflating bag in association with laryngeal mask airway, combitube, and bag-valve-face mask may provide adequate lung ventilation, while reducing the risk of gastric inflation in a bench model simulating the initial phase of CPR.

Sixteen intensive care unit registered nurses volunteered for our study. Use of a paediatric versus adult self-inflating bag resulted in a significantly ($P < 0.01$) lower mean (\pm S.D.) tidal lung volume with both the laryngeal mask airway and combitube (laryngeal mask airway 349 \pm 149 ml versus 725 \pm 266 ml, combitube 389 \pm 113 ml versus 1061 \pm 451 ml).

Lung tidal volumes were below the European Resuscitation Council recommendation with both self-inflatable bags in the bag-valve-face mask group (paediatric versus adult self-inflatable bag 256 \pm 77 ml versus 334 \pm 125 ml). Esophageal tidal volumes were significantly ($P < 0.05$) lower using the paediatric self-inflatable bag in the bag-valve-face mask group; almost no gastric inflation occurred with the laryngeal mask airway, and none with the combitube.

In conclusion, use of the paediatric self-inflating bag may reduce gastric inflation, but measured lung tidal volumes are below the European Resuscitation Council recommendation when used with either, the laryngeal mask airway, combitube, or bag-valve-face mask.

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Resuscitation 1999 Dec;43(1):25-9

6 Effects of smaller tidal volumes during basic life support ventilation in patients with respiratory arrest: good ventilation, less risk?

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OBJECTIVE: When ventilating an unintubated patient in cardiac or respiratory arrest, smaller tidal volumes of 500 ml instead of 800-1200 ml may be beneficial to decrease peak airway pressure, and to minimise stomach inflation.

The purpose was to determine the effects of small (approximately 500 ml) versus large (approximately 1000 ml) tidal volumes given with paediatric versus adult self-inflatable bags and approximately 50% oxygen on respiratory parameters in patients during simulated basic life support ventilation.

METHODS: While undergoing induction of anaesthesia, patients were randomised to three minutes of ventilation with either an adult (n = 40) or paediatric (n = 40) self-inflatable bag.

RESULTS: When compared with an adult self-inflatable bag, the paediatric bag resulted in significantly lower mean (+/- standard deviation) exhaled tidal volume (365 +/- 55 versus 779 +/- 122 ml; P < 0.0001), peak airway pressure (20 +/- 2 versus 25 +/- 5 cm H₂O; P < 0.0001), but comparable oxygen saturation (97 +/- 1% versus 98 +/- 1%; NS (nonsignificant)).

Stomach inflation occurred in five of 40 patients ventilated with an adult self-inflatable bag, but in no patients who were ventilated with a paediatric self-inflatable bag (P = 0.054).

CONCLUSION: Administering smaller tidal volumes with a paediatric instead of an adult self-inflatable bag in unintubated adult patients with respiratory arrest maintains good oxygenation and carbon dioxide elimination while decreasing peak airway pressure, which makes stomach inflation less likely.

Bag Valve Mask (BVM) Research Studies

Respir Care 1992 May;37(5):432-8

7 An evaluation of the resistance to flow through the patient valves of twelve adult manual resuscitators.

Hess D, Simmons M

York Hospital, PA 17405.

What is the inspiratory and expiratory resistance to flow through the patient valves of adult manual resuscitators?

MATERIALS & METHODS: We evaluated the resistance to flow through the patient valves of 12 adult resuscitators (Ambu, Code Blue, DMR, Hope 4, Hospitak, Hudson, Intertech, Laerdal, Mercury, Respirationics, SPUR, Vitalograph).

Expiratory resistance was evaluated by directing a flow of oxygen through the valve in the direction that the patient expires. Inspiratory resistance was evaluated by directing oxygen through the valve in the direction of flow when the bag is squeezed.

Flow was controlled by a Timeter 0-75 flowmeter, and measured using a calibrated Timeter RT-200. Flows of 10, 20, 30, 40, 50, 60, 70, 80, and 90 L/min were used. Resistive back pressure of the resuscitator valves was measured using a calibrated Timeter RT-200. Resistance was calculated by dividing back pressure by flow. Five measurements were made at each flow setting for each resuscitator.

RESULTS: Significant differences in back pressures and resistances existed between the resuscitators for both expiratory and inspiratory flows (p less than 0.001 in each case). Significant interaction effects also existed between resuscitator brands and flows (p less than 0.001 in each case).

At an expiratory flow of 50 L/min, all resuscitators except the Hospitak and Vitalograph produced a back pressure less than 5 cm H₂O (the International Standards Organization standard). At an inspiratory flow of 50 L/min, all resuscitators but the Hospitak, Mercury, and Vitalograph produced a back pressure less than 5 cm H₂O.

CONCLUSIONS: Significant differences existed in the back pressures produced due to the flow resistance through the patient valves of these resuscitators, and these might be considered excessive in some cases. Because this was a bench study, further work is needed to determine the clinical importance of these findings.

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Respir Care 1991 Mar;36(3):161-72

8 Evaluation of ten manual resuscitators across an operational temperature range of -18 degrees C to 50 degrees C.

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Because of the temperature extremes encountered during emergency resuscitation and transport in the field, we sought to evaluate the performance and safety of 10 adult resuscitators (5 permanent units: Hope 4, Laerdal, Lifesaver, Mark 3, and PMR; and 5 disposable units: BagEasy, Code Blue, CPR Bag, DMR, and SPUR) across an operational temperature range of -18 degrees C to 50 degrees C.

METHOD: We tested the devices against the American Society for Testing and Materials (ASTM) Standard F-920 and the International Organization for Standardization (ISO) Standard 8382. We tested each resuscitator by using a lung model, the Bio-Tek VT-1 Ventilator Tester.

RESULTS: All of the resuscitators met the ventilation requirements for VT and F (600 mL X 20) and I:E less than 1:1 except the SPUR at -18 degrees C. Standards ASTM F-920 and ISO 8382 specify a fractional delivered oxygen concentration (FDO₂) of greater than or equal to 0.85 with attachments and greater than or equal to 0.40 without attachments at oxygen flow of 15 L/min and VE of 7.2 L/min (600 mL X 12).

Nine resuscitators met Standards ASTM F-920 and ISO 8382 for FDO₂ with attachments at 21 degrees C and 50 degrees C, but only 3 units (Code Blue, DMR, and PMR) passed at -18 degrees C. At 21 degrees C, the Hope 4 had an FDO₂ of 0.77 +/- 0.03, which was significantly lower (p less than 0.001) than that of the other 9 resuscitators, all of which were greater than or equal to 0.93.

Nine resuscitators met the FDO₂ standard without attachments. All 10 resuscitators passed the tests for valve function after contamination with simulated vomitus (at an oxygen flow of 30 L/min) and for backward leakage. At the ventilation pattern recommended by the American Heart Association (AHA) (800 mL X 12) the PMR's mean FDO₂ dropped to 0.86 +/- 0.03 because of air leaking into the bag where it attaches to the patient-valve assembly. All 10 resuscitators passed the test for mechanical shock at 21 degrees C and 50 degrees C, but 3 units failed at -18 degrees C.

CONCLUSION: We conclude that only the Code Blue and DMR meet the ASTM and ISO standards for operator-powered adult resuscitators across the operational temperature range of -18 degrees C to 50 degrees C.

Bag Valve Mask (BVM) Research Studies

Respir Care 1990 Oct;35(10):960-8

9 Evaluation of ten disposable manual resuscitators.

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We evaluated the performance and safety of 10 disposable resuscitators -- six adult units: SPUR, Code Blue, 1st Response, Hospitak MPR, CPR Bag, and Pulmanex; and four pediatric units: CPR Bag, 1st Response, Hospitak MPR, and LSP Bag Mask.

METHOD: We tested the devices against the American Society for Testing and Materials (ASTM) Standard F-920. We tested each resuscitator by using a lung model, the Bio-Tek VT-1 Ventilator Tester.

RESULTS: All resuscitators met the ventilation requirements for VT and f (adult: 600 mL x 12/min; child: 300 mL x 20/min and 70 mL x 30/min) and I:E less than 1:1. Standard F-920 specifies a fractional delivered O₂ concentration (FDO₂) greater than or equal to 0.85 with attachments and greater than or equal to 0.40 without attachments, at oxygen flow of 15 L/min, and VE of 7.2 L (600 mL x 12/min) for adult units and VE of 6 L (300 mL x 20/min) for pediatric units. All 10 resuscitators met standard F-920 for FDO₂ with attachments. Nine resuscitators met the FDO₂ standard without attachments.

The 10 resuscitators passed the test for valve function after contamination with simulated vomitus, at an oxygen flow of 30 L/min, and for backward leakage. Three pediatric resuscitators (1st Response, Hospitak MPR, and LSP Bag Mask) did not pass the pressure-limit requirement of 40 +/- 10 cm H₂O. Four resuscitators, Hospitak MPR (adult and pediatric) and CPR Bag (adult and pediatric), were unable to pass the test for mechanical shock (a fall from a height of at least 1 meter).

CONCLUSION: We conclude that only Code Blue, 1st response, Pulmanex (with tube-type reservoir), and SPUR meet ASTM Standard F-920 and are acceptable replacements for permanent resuscitators.

Bag Valve Mask (BVM) Research Studies

Respir Care 1990 Aug;35(8):800-5

10 An evaluation of volumes delivered by selected adult disposable resuscitators: the effects of hand size, number of hands used, and use of disposable medical gloves.

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York Hospital, PA.

Due to increasing concern over potential cross-infection during cardiopulmonary resuscitation (CPR), a number of disposable resuscitators have become commercially available. The wearing of disposable medical gloves by persons performing CPR has also become commonplace. In this study, we evaluated the effects of hand size, use of disposable medical gloves, and number of hands used (one versus two) on the volumes delivered by five adult disposable resuscitators.

METHOD: Persons familiar with bag-valve ventilation were recruited to participate in the study--eight with small hands, eight with medium hands, and eight with large hands. Ventilation was delivered to one side of a Vent-Aid training test lung (TTL), and volumes were measured with a BEAR VM-90. In random order, each participant ventilated the TTL with all combinations of one hand/two hands, gloves/no gloves, and each of the following resuscitators: Code Blue, Hospitak, Pulmanex, Mercury, and Ambu SPUR. The participants were instructed to ventilate the TTL as they would ventilate a patient.

RESULTS: The mean \pm SD volumes (in liters) were small hands = 0.68 \pm 0.15, medium hands = 0.71 \pm 0.18, large hands = 0.81 \pm 0.19 ($p=0.006$); gloves = 0.73 \pm 0.19, no gloves = 0.73 \pm 0.18 ($p=0.80$); one hand = 0.62 \pm 0.12, two hands = 0.84 \pm 0.17 (p less than 0.0001); Code Blue = 0.79 \pm 0.14, Hospitak = 0.56 \pm 0.11, Pulmanex = 0.71 \pm 0.15, Mercury = 0.77 \pm 0.18, SPUR = 0.83 \pm 0.2 (p less than 0.0001).

CONCLUSIONS: The use of gloves did not significantly affect volume delivery. Delivered volumes did increase significantly as hand size increased and as number of hands used to squeeze the bag increased, and observed differences in volume delivery between brands of resuscitators may be clinically important in some cases. This study emphasizes the importance of squeezing the resuscitator with two hands during bag-valve ventilation.

Bag Valve Mask (BVM) Research Studies

Resuscitation 1998 Jul;38(1):7-12

11 A comparison of standard and a modified method of two resuscitator adult cardiopulmonary resuscitation: description of a new system for research into advanced life support skills.

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The study compares two methods of Advanced Life Support by a pair of resuscitators using a bag-valve-mask (BVM) technique. Standard two resuscitator cardiopulmonary resuscitation (CPR) was compared with a modified method of two resuscitator CPR. During the modified CPR one resuscitator held the face mask while the other resuscitator alternates between squeezing the self inflating bag and performing simulated cardiac compressions.

Standard CPR was performed at a ventilation: compression ratio of 1:5 while modified CPR was performed at a ventilation: compression ratio of 2:15.

Comparisons were made during induction of anaesthesia in 30 ASA I and II patients. Modified CPR produced a greater tidal volume (TV) ($P < 0.001$), a slower respiratory rate (RR) ($P < 0.001$) and a faster compression rate (CR) ($P < 0.01$) (means with (S.D.): modified CPR: TV 990 (220) ml, RR 6 (1) min⁻¹, CR 82 (8) min⁻¹); standard CPR: TV 570 (190) ml, RR 10 (2) min⁻¹, CR 65 (11) min⁻¹)).

A new method for the simultaneous computerised recording of simulated cardiac compressions together with mask pressure and expired gas composition in anaesthetised patients is described.

Bag Valve Mask (BVM) Research Studies

Resuscitation 1998 Jul;38(1):3-6

12 The incidence of regurgitation during cardiopulmonary resuscitation: a comparison between the bag valve mask and laryngeal mask airway.

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The risk of gastric regurgitation and subsequent pulmonary aspiration is a recognised complication of cardiac arrest--a risk which may be further increased by the resuscitative procedure itself. The purpose of this study was to compare the incidence of gastric regurgitation between the bag valve mask (BVM) and laryngeal mask airway (LMA).

The resuscitation data collection forms of 996 patients who underwent in-hospital cardiopulmonary resuscitation over a 3.5 year period were reviewed. Of these, 199 patients were excluded from the study because there was no airway management involving a BVM or LMA. The incidence and timing of regurgitation was studied in the remaining 797 patients. Regurgitation was recorded to have occurred at some stage in 180 of these patients (22.6%).

However, 84 regurgitated prior to CPR (46.7% of those patients who regurgitated). These patients were excluded from further analysis as regurgitation could not have been affected by any form of ventilation. Of the remaining 713 patients, BVM ventilation was used in 636 cases.

In 170 of these the LMA was also used following the BVM. Where the patient was ventilated with the BVM alone or BVM followed by ETT the incidence of regurgitation during CPR was 12.4%. The LMA was used during resuscitation in 256 cases of which 170 had BVM ventilation prior to the LMA.

Where the patient was ventilated with the LMA alone or LMA followed by ETT the incidence of regurgitation during CPR was 3.5%. The study confirms experience reported in earlier studies that when an LMA is used as a first line airway device, regurgitation is relatively uncommon.

Bag Valve Mask (BVM) Research Studies

Resuscitation 1997 Jan;33(3):207-10

13 A comparison of three methods of bag valve mask ventilation.

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A method of bag valve mask ventilation in which the resuscitator compresses the self inflating bag between their open palm and the side of their body was compared with conventional single and two resuscitator bag valve mask ventilation.

Fifteen nurses each ventilated three patients for 4 min following the induction of general anaesthesia, using one method per patient in random order. Tidal volume and peak mask pressures were higher with the two resuscitator technique than with either form of single resuscitator ventilation; There were no significant differences between the two methods of single resuscitator ventilation.

Tidal volume: mean (S.D.); 'open palm': 270 ml (160); single resuscitator: 260 ml (220); two resuscitators: 480 ml (210). Peak mask pressure (mmHg): mean (SD); 'open palm': 19 (8); single resuscitator: 17(9); two resuscitator: 28 (11).

Bag Valve Mask (BVM) Research Studies

Ann Emerg Med 1995 Jul;26(1):25-30

14 Three-rescuer CPR: the method of choice for firefighter CPR?

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STUDY OBJECTIVE: To compare the quality of CPR provided by firefighters performing three-rescuer CPR with that achieved by firefighters trained to provide standard two-rescuer CPR.

DESIGN: Eight months after training a large number of firefighters to perform three-rescuer CPR, we used a quasi-experimental design to compare the performance of a randomly selected subset of these companies to that achieved by a control group of engine companies that received refresher training in standard two-rescuer CPR. Both groups used bag-valve masks to provide rescue ventilations.

Testing was conducted on a no-notice basis with a recording mannequin. Key actions were scored by an experienced observer using explicit pass-fail criteria. Mannequin-generated strip charts were used to calculate the rate and depth of chest compressions and the ventilatory rate, volume, and minute ventilation in a blinded manner.

SETTING: Fire stations of the Memphis Fire Department. The department is the sole provider of first-responder emergency care to the citizens of Memphis, Tennessee (population, 610,000).

RESULTS: Three-rescuer teams delivered a mean minute ventilation substantially greater than that produced by two-rescuer teams (7.7 +/- 5.3 L versus 4.9 +/- 4.2 L, $P < .001$). Intergroup differences in the mean depth of chest compressions were less marked, but they were still significant (17.2 +/- 8.3 mm of recorder-needle deflection versus 13.7 +/- 7.0 mm, $P < .001$).

CONCLUSION: Three rescuers can produce better CPR than two when a bag-valve-mask device is used. The technique is easily learned and readily retained.

Bag Valve Mask (BVM) Research Studies

Am J Crit Care 1993 Nov;2(6):467-73

15 Comparison of tidal volumes obtained by one-handed and two-handed ventilation techniques.

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OBJECTIVES: To compare tidal volumes delivered by one- vs two-handed compressions of a manual resuscitation bag and assess the effects of subject characteristics on those tidal volumes.

DESIGN: Subjects (108 healthcare providers from a 500-bed teaching hospital) were assigned randomly to one of two procedures: one- followed by two-handed compression or two- followed by one-handed compression. A 1-liter resuscitation bag, lung performance analyzer and Wright spirometer were used to measure tidal volume. Data collection occurred in a simulated situation.

RESULTS: There was a significant difference in tidal volume delivered by one-handed (mean = 694 mL, SD = 111) vs two-handed compressions (mean = 827 mL, SD = 113). Hand size, grip strength, height and weight were correlated with tidal volumes generated by one-handed and two-handed procedures. No other subject characteristics were correlated with tidal volumes.

CONCLUSIONS: Tidal volumes delivered by healthcare providers using one- vs two-handed compressions were found to be significantly different, with those delivered by two hands significantly greater than those delivered by one hand. Strength of hand grip was the best predictor of volume delivered and was more strongly correlated with volumes delivered by one rather than two hands.

Bag Valve Mask (BVM) Research Studies

Resuscitation 1993 Oct;26(2):173-6

16 A new method of two-resuscitator CPR.

Thomas AN, Weber EC

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Standard two-resuscitator cardiopulmonary resuscitation (CPR) (one resuscitator providing Bag Valve Mask (BVM) ventilation and one chest compressions) was compared with a modified method where one resuscitator held the mask while the second provided ventilation and compressions.

Twenty-two subjects used both methods in random order on a recording manikin equipped to measure minute volume (Vm), tidal volume (Vt), respiratory rate (RR), compression rate (CR) and depth. Vm and Vt were greater with modified CPR, but the CR was slower.

Percent of compressions < 38 mm, 38-51 mm or > 51 mm did not differ between techniques ((Modified--VM, 12.6 l (S.D. 2.5); Vt, 1110 ml (S.D. 116); CR, 57 (S.D. 11), < 38 mm 6% (S.D. 14), 38-51 mm 36% (S.D. 33), > 51 mm 58% (S.D. 41); Standard--Vm, 9.7 l (S.D. 3.8); Vt, 640 ml (S.D. 230); CR, 75 (10), < 38 mm 9% (S.D. 22), 38-51 mm 52% (S.D. 37), > 51 mm 38% (S.D. 38)).

Modified CPR greatly improves ventilation but reduces CR.

Bag Valve Mask (BVM) Research Studies

Anaesthesia 1992 Nov;47(11):936-8

17 Estimation of tidal volume from the reservoir bag. A laboratory study.

Kulkarni PR, Lumb AB, Platt MW, Nunn JF

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The accuracy of 21 anaesthetists in estimating tidal volumes from reservoir bag movements was assessed using a model lung apparatus. The breathing system configuration (Mapleson A or D), the grade of anaesthetist, and the years of anaesthetic experience had no effect on accuracy.

Greater precision of tidal volume estimation was observed with larger tidal volumes and lower fresh gas flows. The mean systematic error of 18 of the 21 anaesthetists was greater than zero, indicating a general tendency to overestimate tidal volume.

This study therefore strengthens the view that clinical observations should be supplemented with information from continuous monitoring devices.

Bag Valve Mask (BVM) Research Studies

Br J Anaesth 1992 Oct;69(4):397-8

18 A new technique for two-hand bag valve mask ventilation.

Thomas AN, Dang PT, Hyatt J, Trinh TN

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A method of bag valve mask ventilation (BVM) in which the resuscitator compresses the self-inflating bag between the open palm and body was compared with both standard single resuscitator and two-resuscitator BVM ventilation.

Eighteen subjects ventilated a modified recording manikin using each method in random order. The tidal volume (VT) was greater with the open palm (mean 684 (SD 182) ml) than standard single resuscitator ventilation (mean 520 (152) ml).

The difference was greater in the nine subjects with small hands (mean 196 (103) ml). VT was less than with two-resuscitator ventilation (mean VT 953 (236) ml).

Bag Valve Mask (BVM) Research Studies

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19 Infant ventilation and oxygenation by basic life support providers: comparison of methods.

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INTRODUCTION: Little information is available in the performance of infant ventilation by basic life support (BLS) personnel.

HYPOTHESIS: There are no significant differences between mouth-to-mouth (M-M), mouth-to-mask (M-Ma), pediatric bag-mask (PBM), and adult bag-mask (ABM) devices in the percent of acceptable breaths delivered by BLS providers.

METHODS: Fifty certified BLS providers performed five ventilation methods in random sequences for 60 seconds each on a 5kg infant mannequin following standardized instructions. Supplemental oxygen, 10 l/min, was supplied with one M-Ma trial and PBM methods.

Airway patency, peak airway pressure (PAP), ventilatory rate (VR), tidal volume, and delivered oxygen concentration (FiO₂) were recorded. The percent of breaths with excessive PAP (i.e., greater than 30 mmHg), percent of acceptable breaths using loose (i.e., 25-125ml) and strict (i.e., 50-100ml) criteria, and FiO₂ at 15, 30, 45, and 60 seconds were compared between ventilation methods using ANOVA.

RESULTS: For all subjects and those with a patent airway (n=36), there were no significant differences in the percentage of acceptable breaths produced by PBM (56+/-6) (mean+/-SEM; all subjects) and ABM (41+/-6.2) was significantly greater than M-Ma, with and without a patent airway. Although RR and the percentage of excessive breaths were not significantly different, the percentage of acceptable breaths and FiO₂ delivered with each ventilation method was significantly better in the patent airway group.

Bag Valve Mask (BVM) Research Studies

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20 Evaluation of mask-bag ventilation in resuscitation of infants.

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Performance of mask-bag ventilation was evaluated on an infant resuscitation mannequin to resolve uncertainty regarding the proficiency of pediatric resuscitation personnel in this technique and to determine whether the type of resuscitation bag used would affect performance. Performance using a self-inflatable resuscitation bag was generally adequate.

Forty-six of 50 operators achieved an adequate minute ventilation, and 48 of 50 operators achieved a mean tidal volume exceeding that of the mask plus simulated physiologic dead space.

Wide variation with a tendency to hyperventilate and to use excessive pressures indicate the need for improved standard training methods. Technical difficulties with an anesthesia bag impaired performance, suggesting that only self-inflatable bags should be used for mask-bag ventilation during pediatric resuscitation, unless the staff's proficiency with anesthesia bags is clearly demonstrated.