Butterfly BVM vs. Traditional BVM: A Comparative Study in Prehospital Ventilation

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Background

The adult bag-valve-mask (BVM) typically has more volume than needed for proper ventilation, with volumes of 600-1000ml. Adult BVMs usage have been seen to exceed tidal volume recommendations (500–600 mL per breath for adults) and can result in overventilation if not carefully controlled. Simulation studies have shown that median tidal volumes with adult BVMs frequently range from 981-994 mL when utilizing either endotracheal tube or an extraglottic device, which is above the recommended range of lung protective strategies recommended by the European Resuscitative Council (ERC) of 6-8 mL/kg of ideal body weight. Pediatric BVMs, when used on adults, deliver lower tidal volumes typically closer to or within lung-protective ranges. Studies demonstrate that pediatric BVMs provide median tidal volumes of 547–664 mL, and a higher proportion of breaths within the recommended range for a 70 kg adult compared to adult BVMs. Justice JM et al suggest BVM size alone does not guarantee guideline-compliant ventilation; technique, mask seal, and provider training are also critical. A novel device called Butterfly BVM (Compact Medical, Inc.) has been developed to address these issues encountered with a standard BVM. The Butterfly BVM gives users control over tidal volume and peek inspiratory pressure (PIP), with the ability to adjust for infant, pediatric, and adults in a single device. The Butterfly BVM was shown to be able to deliver tidal volume for an adult simulated patient within 4-8 ml/kg range, which is more consistent with ERC guidelines. In summary, adult BVMs risk overventilation, while pediatric BVMs may better approximate lung-protective volumes but can risk under-ventilation if not used with supplemental oxygen or proper technique. Optimal tidal volume delivery in the prehospital setting requires attention to BVM size, technique, and real-time assessment of chest rise and oxygenation. The Butterfly BVM may be a viable choice for applying proper tidal volume to patients in the prehospital setting. We aim to assess the ability of the Butterfly BVM to deliver artificial ventilations and appropriate tidal volume and respiratory rates to a mannequin relative to published guidelines and relative to a traditional BVM (AmbuBag).

Objectives

Primary Aim: Assess the ability of the Butterfly BVM to deliver artificial ventilation and appropriate tidal volume and respiratory rates to a mannequin relative to published guidelines and relative to a traditional BVM (AmbuBag).

Secondary Aim: Assess provider satisfaction with the Butterfly BVM device

Methods

The study uses a one-group within-subjects design, in which the emergency medical technician (EMT) or paramedic will experience both conditions (traditional BVM and Butterfly BVM). We will recruit 20 subjects. During the study, participants will demonstrate their proficiency in administering artificial respirations via endotracheal tube to a simulated patient (henceforth labeled as a “mannequin”) using a traditional bag-valve-mask resuscitator (BVM – colloquially referred to as an “Ambu” bag) and then using a novel bag-valve-mask resuscitator called the Butterfly BVM.

The sample size for our study was calculated by a biostatistician at Sarasota Memorial Hospital, based on the outcome measure of breaths per minute. In a similar study by Aufderheide et al., the average maximum number of breaths per minute for a group of subjects performing CPR with an assist device was found to be 37 (12). After retraining, the average maximum number of breaths per minute was 22. It is assumed that the mean breaths per minute during CPR at baseline in the proposed study will be approximately 25 and will be reduced to 15 using the new device. Using a paired t-test with a significance level of 0.05 and assuming that the standard deviation of the changes will be 12, a sample size of 20 subjects will provide >90% power to detect the hypothesized difference.

Inclusion Criteria:

- Must be a licensed EMT-P currently working in the field of EMS
- Must be willing and able to sign consent and engage in study activities

Exclusion Criteria:

- Individuals who decline participation and/or do not sign the consent documents
- Children and minors

Results

Preliminary results collected

A total of 20 EMT-B and EMT-P practitioners participated in this study

The average years of experience = 14.8

Standard BVM

- Average Tidal Volume given – 670.75cc
- Tidal volume ranges from 378 cc to 951 cc
- Average breath per minute given of 8.95

Butterfly BVM

- Average Tidal Volume given – 506.95cc
- Tidal volume ranges from 384cc to 610cc
- Average breath per minute rate of 10.85

Discussion

AMBU bags have long been used as the device to deliver breaths prehospital and in hospital.

Our study, although preliminary, does begin to show the benefit of the Butterfly BVM

Compared to the standard BVM, the average tidal volume given for an average adult (approximately 80-100 kgs) with the Butterfly BVM more closely reflects the volumes recommended for lung protective measures.

Given the average tidal volume of the Butterfly BVM is 506.92 cc per breath, this falls well within the recommendation of 4-6 cc/kg of tidal volume.

There is also what appears to be less of a range and mor consistent tidal volumes given with the Butterfly BVM

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