Improvement in Bag-Mask Ventilation Performance After Training With a Novel Terminal Feedback Manikin System

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BACKGROUND

- Bag-mask ventilation (BMV) is commonly used in emergency and prehospital care.
- With the de-emphasis of endotracheal intubation, BMV has become increasingly important in cardiac arrest and prehospital management of traumatic brain injury.
- BMV is considered a basic skill, often taught only by demonstration and brief practice.
- Poorly performed BMV is common, resulting in brief, high-volume inspirations delivered at a rapid rate.
- Consequences include gastric inflation, an increase in intrathoracic pressure with resultant hypotension, and hypocarbia reducing cerebral blood flow.
- Despite poor performance and known complications, training methods have remained largely unchanged.
- A well known and effective method to learn motor skills is terminal feedback - performance assessment provided after task completion.

OBJECTIVE

- To measure adequacy of performance in bag-mask ventilation in each of three parameters: duration of inspiration (1 second), volume of inspiration (500-600 mL), and duration of breath-to-breath interval (5-6 seconds).
- To evaluate the performance improvement impact of visual feedback training.

Ambu SmartMan© Feedback Display

METHODS

Design: Prospective pre-post interventional study.
Subjects: Twenty-eight volunteer on-duty EMTs and paramedics performed bag-mask ventilation on a SmartMan© adult CPR manikin system from Ambu, Inc. and remained blinded to the results.
- Subjects were then trained for 1 minute using the SmartMan continuous terminal feedback (bandwidth knowledge of results) training system, utilizing a color bar display to indicate specified ranges for "acceptable", "too high" and "too low" on each of the three parameters. A second blinded assessment was then done for all subjects.
- To account for potential correlations among ventilations for each subject, a cluster analysis was performed using generalized estimating equations and an exchangeable covariance matrix; proportional odds ratios (OR) with 95% confidence intervals were calculated.

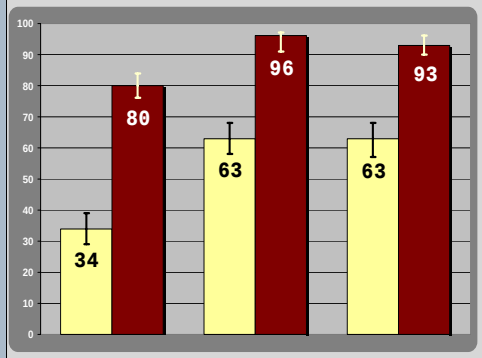
Outcome measures:
- Adequacy of duration of inspiration, volume of inspiration, and duration of breath-to-breath interval.
- Performance differences before and after training intervention.

SmartMan Training/Testing

RESULTS

- Twenty-eight subjects performed a total of 672 total breaths, 336 per trial.
- Individual measurements were considered correct if performed to within 20% of the AHA Guidelines for ventilations.
- Acceptable ranges: Duration of inspiration 0.8-1.2 seconds, volume of inspiration 400-700 mL, breath-to-breath interval 4-7 seconds.
- Correctly performed duration of inspiration increased from 34% of ventilations to 80%.
- Proportion delivered too rapidly decreased from 50% to 15%.
- Correct volume of inspiration increased from 63% to 96%.
- Correct breath-to-breath interval increased from 63% to 93%.
- All pre-post intervention differences were significant (P<0.0001).

BMV Performance
(% correct, 95% CI)



CONCLUSIONS

- There is accumulating evidence that deficiencies in BMV skills worsen patient outcomes.
- Initial BMV was performed inconsistently over a wide range of durations and volumes.
- Too-rapid inspiration was the most common error, occurring in nearly 50% of breaths.
- A brief visual terminal feedback training session substantially improved performance, with a large majority of breaths delivered within acceptable ranges.
- Correct inspiratory rate and volume with bag-mask ventilation appears to be a learnable skill.
- Terminal feedback methods of training can optimize motor skills learning and performance.

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