Audiovisual Feedback from a Handheld Monitoring Device Improves Manual Ventilation

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Introduction

Short-term emergency ventilation is mostly accomplished through bag valve mask (BVM) systems. BVMs are cost-effective and easily transported but are also quite prone to user error, especially in high-stress emergent situations. **Inaccurate and erratic manual ventilation has the potential to greatly harm a patient.**[1] The goal of this project was to create a device with the following functions:

- **Monitor tidal volumes delivered by manual ventilators**
- **Provide real-time feedback on the depth and quality of respirations**
- **Inform users when to begin and end respiration**

Using our device, called the **BVM Emergency Narration Guided Instrument (*BENGI*)**, healthcare providers would be able to provide consistent and accurate tidal volumes, minimizing the risk of causing inadvertent trauma to a patient and improving pre-hospital patient outcomes.

Validation Methods

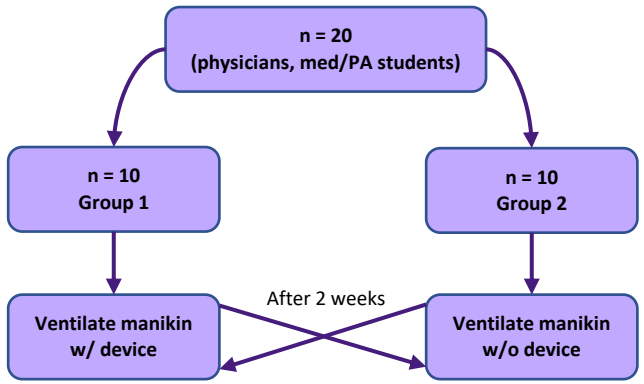

Figure 1. Randomized crossover manikin study design

Device Design

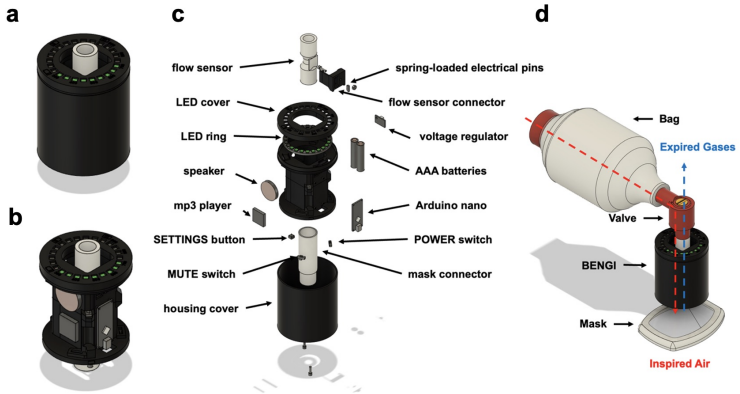

Figure 2. Assembled (a, b) and exploded (c) views of the BENGI prototype, with a diagram of the device in-line with a BVM system (d)

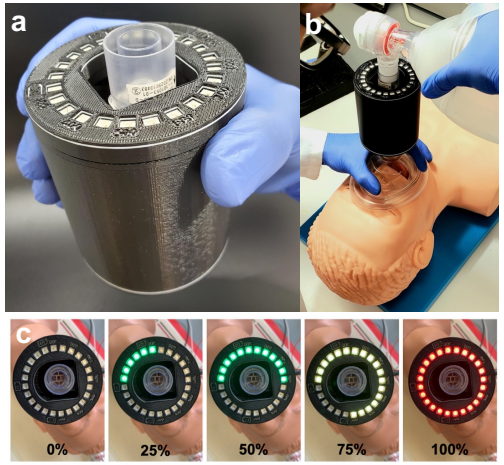

Figure 3. Photographs of the assembled BENGI (a, b), with an LED ring showing the delivered tidal volume as a percentage of the target tidal volume (c)

Results

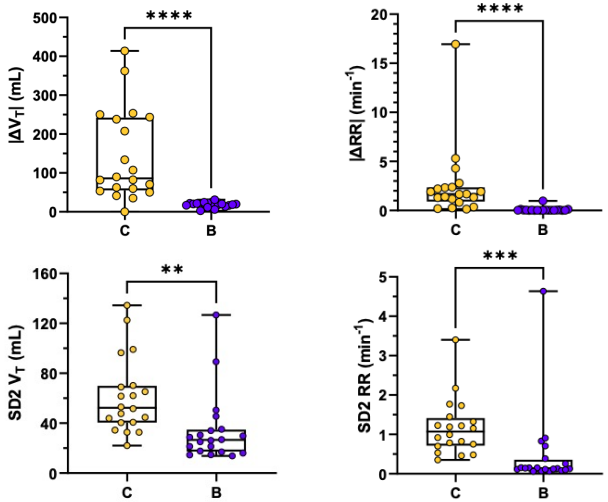

Figure 4. Absolute error (top) and long-term standard deviation (bottom) in delivered tidal volumes and respiratory rates while using (B) and not using (C) the BENGI

- **BENGI use significantly reduced deviations in tidal volume and respiratory rates from the target values**
- **Long-term variations in delivered tidal volume and respiratory rate were also reduced**

Conclusions

- **BENGI use improved both tidal volume and respiratory rate accuracy and consistency in a manikin simulation study**
- **The BENGI may have utility as a medical device for improving the quality of manual ventilation and reducing the sequelae associated with manual hyper- and hypoventilation**
- **Future work will include testing the efficacy of the BENGI as a training device**

****A USPTO non-provisional application has been filed on this technology****

1. Dafilou B, Schwester D, Ruhl N, Marques-Baptista A. It's In The Bag: Tidal Volumes in Adult and Pediatric Bag Valve Masks. *West J Emerg Med*. 2020;21(3):722-726. Published 2020 Apr 27. doi:10.5811/westjem.2020.3.45788