INTRODUCTION

- The concept of “airway first” is echoed in the “ABC” mnemonic (airway, breathing, circulation). The importance of early restoration of ventilation through interventions such as BVMV is supported by incorporation of these skills as key elements of certification in both Basic Life Support (BLS) and Advanced Cardiac Life Support (ACLS).
- Increasing numbers of non-anesthesia providers are providing procedural sedation in non-operating room settings. The expanding number and increased patient acuity in these settings raises concerns about the ability of inexperienced providers to initiate early ventilation.
- Several pre- and in-hospital studies have demonstrated difficulties providing adequate ventilation across provider domains.
- Competency based education including critical skills such as BVMV has been advocated, with the American Society of Anesthesiologists, American Association of Nurse Anesthetists and JCAH published practice guidelines and accreditation requirements.
- Unfortunately, there are no widely available, comprehensive and standardized training programs for non-anesthesia providers incorporating quantitative measurement and development of key skills such as BVMV.

PURPOSE

The overall purpose of this IRB approved study (IRB#0607031) is to perform benchmarking and validation of a novel BVMV evaluation system. The specific goals of this project are:

1. To evaluate the technical feasibility of quantitatively measuring volumes delivered during BVMV of a Laerdal SimMan™ by inserting a Hans Rudolph RSS 100™ bidirectional flow meter into the distal trachea.
2. To develop proprietary software for the National Instruments LabView data acquisition system capable of measuring inspiratory/expiratory volumes, respiratory rate and airway pressures.
3. To develop specific breath detection algorithms to identify flow waveform patterns unique to BVMV (i.e. interrupted flow due to inadequate mask seal).
4. To assess validity (consensus and construct) of this ventilation system as a model of Bag-Valve-Mask Ventilation (BVMV) of a human being.

METHODS AND TOOLS

- A Laerdal SimMan™ High Fidelity Human Simulator was modified, fitting a Hans Rudolph™ RSS 100™ bidirectional flow meter system into the distal ‘trachea’. The selected flow sensor was chosen so as to limit changes to the internal diameter of the trachea.
- Proprietary software was developed for the LabView™ data acquisition system to collect and analyze raw signals from the RSS 100 system. This software is able to measure inspired/expired flows, respiratory rate and airway pressures.
- Static bench testing of the flow meter system and the software was done using a Hans Rudolph Series 5530 3-liter calibration syringe. Testing was done both outside of SimMan™ and with the flow probe inserted in the distal trachea. Methods to calibrate the flow meter while in the SimMan™ were developed.

BENCH TESTING RESULTS AND POTENTIAL IMPACT

- Trial of calibration configurations with the flow meter in SimMan. Size 9.0 mm endotracheal tube positioned proximal or distal to the glottic opening with the SimMan chest plate either on or off. "Catheterized Membrane" opening sealed with custom fit rubber stopper. Volumes injected compared with ‘in-vivo’ flow measurements.

- A quantifiable measure of performance during BVMV could allow for development of metrics for the production and deployment of more effective training protocols and possibly competency based certification.
- A thorough evaluation of consensus and construct validity of one system used for teaching BVMV skills (Laerdal SimMan™) could either confirm utility or suggest modifications for improvement. Phase 2 of this protocol will attempt to address validity by having a range of health care providers use and assess the system.