A novel model for massive pulmonary hemorrhage management training – demonstration of training utility in pediatric anesthesiologists

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Introduction:
Massive pulmonary hemorrhage (MPH) is an airway emergency that requires immediate intervention, such as with bronchial blockade. Although bleeds of this magnitude are uncommon,[1] the associated mortality is reported to be as high as 38%.[2] The management of low frequency high acuity events, such as MPH, may benefit from simulation whereby critical care practitioners can safely develop and retain airway skills in low-consequence environments. However, a physical model of MPH for use in simulation has not been previously described. Therefore, the purpose of this project was two-fold: 1) to develop a model of MPH; 2) to apply the model in simulation with attending pediatric anesthesiologists and evaluate its utility.

Methods:
The model of MPH (Fig. 1) and the simulation environment were created in consultation with experts in anesthesiology, pulmonology, and human factors/simulation. A 20 mL bolus of artificial blood (Ben Nye, California, USA) is injected into each the oropharynx and the left bronchioles of a carbon fibre AirSim Advance Bronchi X manikin (TruCorp, Lurgin, Northern Ireland), which features internally accurate respiratory anatomy. Next, the artificial blood is pumped at a rate of 600 mL/hr via a catheter into the base of the left bronchial tree. Balloons located at the end of each bronchial tree serve as "lungs" and are used to indicate whether bronchial blockade and unilateral ventilation has been successfully achieved. The model has the capacity to elicit coughs, which reproduce the expected physiological response to airway stimulation. To evaluate the model, trials took place in an operating room in the hospital. Twenty attending pediatric anesthesiologists were recruited. Following written informed consent, participants completed a pre-study demographic questionnaire and a practice intubation trial. Next, they

were instructed to perform left-sided single lung isolation of the manikin using four techniques in a stratified random order. Single use disposable bronchoscopes (Ambu Inc., Maryland, USA) were cleaned and reused between trials. A member of the research team served as an anesthesia assistant during the trials. Following the simulation, participants rated an adapted series of affirmative statements,[3] using a REDCap survey: five statements regarding the present MPH simulation, and four statements regarding simulation in general. Five-point Likert scales ranging from strongly disagree, to strongly agree were used. The primary outcome was the average rating across participants for each statement. Open-ended feedback regarding the experience was also collected. Each simulation concluded with a participant-tailored debrief session.

Results:
Data from 20 participants with an average (±SD) number of 13.89 (± 8.02) years of clinical practice, including fellowship, were available for analysis. Six participants had previous experience managing or assisting with the airway in an MPH case. Moderate agreement (3.85 ± 0.93 of 5) that the simulation provided a realistic model of MPH was reported. A high level of agreement amongst the participants on the utility of the simulation in improving their knowledge of devices (4.35 ± 0.59), practical skills (4.25 ± 0.72), and confidence in managing MPH (4.1 ± 0.72) was reported. Importantly, the statement most strongly agreed with was interest in participating in future simulations related to low-frequency airway emergencies (4.8 ± 0.41). A summary of Likert survey responses is presented in Figure 2.

Conclusion:
A model of MPH was developed and demonstrated to have high utility for ongoing training in critical care airway management. The high acuity low frequency nature of MPH highlights its suitability for simulation training, even for senior anesthesiologists with extensive clinical practice. Future work will evaluate the utility of the simulation model in resident trainees, who have less experience with the various methods of single lung isolation in this difficult airway scenario.

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Figure_1.pdf (https://files.aievolution.com/prd/ars2201/abstracts/abs_2658/Figure_1.pdf)
Figure_2.pdf (https://files.aievolution.com/prd/ars2201/abstracts/abs_2658/Figure_2.pdf)

Affirmations

The study was approved by the appropriate IRB or other local review board.
Yes

For studies involving human subjects, written informed consent was obtained from all subjects, a legal surrogate, the parents or legal guardians for minor subjects, or the requirement for written informed consent was waived by the IRB.
Yes

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