A NOVEL SIMULATION CURRICULUM FOR MECHANICAL VENTILATION E IN EMERGENCY MEDICINE RESIDENCY

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Introduction

- The management of mechanically ventilated (MV) patients is very common in the Emergency Department (ED).
- One quarter of patients intubated in the ED remain in the ED for more than five hours, and their mortality is significantly higher than other ICU patients.
- Mortality increases with time in the ED for patients on MV.
- MV initiation and management is not emphasized EM residency training curricula.
- As a result, studies have shown that most EM physicians are not comfortable with ventilator management and that lung-protective ventilation is underutilized in the emergency department.

Project Aim

Provide EM residents with education on and high- fidelity simulation in the management of physiologically variable MV patients through a hybrid lecture-simulation curriculum.

Course Objectives

•Review the foundations of gas exchange and contrast the physiology of positive and negative-pressure ventilation.
•Describe lung mechanics in positive pressure ventilation and their effects on hemodynamics and lung injury.
•Differentiate and employ a variety of mechanical ventilation strategies for desired clinical outcomes across different patient populations.
•Employ high fidelity simulation to train resident physician to choose between forms of mechanical ventilation, safely initiate mechanical ventilation, and titrate setting to defined clinical outcomes.

Design

PARTICIPANTS:
This course was designed for Emergency Medicine residents (EM) (PGY-1 to PGY-3). Medical students on their EM rotation occasionally participated in the simulation sessions but were not part of the data analysis.

LECTURES:
The 45-50 minute lectures were written and delivered by one of the project authors during protected EM didactic education time over the course of the 2023-2024 academic year. The lectures covered the following topics:

- Oxygenation, ventilation, and lung mechanics
- Non-invasive positive pressure ventilation
- MV in obstruction
- MV in restriction
- MV for the management of acid-base disorders
- Respiratory failure in the pregnant patient
- MV in intracranial pathology

SIMULATION SESSIONS
The simulation sessions (Table 1) were integrated into two pre-planned simulation sessions for the residency, focusing on Critical Care (day 1) and Airway Management (day 2). Each case and debrief guide was written by one of the project authors. The sessions were facilitated by one of the project authors or a physician with training in emergency medicine and critical care.

Table 1: Simulation case topics and simulation format. Cases were 60 minutes in length, with 20 minutes dedicated to the simulation case, a 10-15-minute discussion, a 15-minute continuation or "re-run" of the case to drive home educational concepts and a 5-10-minute formal debrief

SIMULATION CASE	FORMAT
Status asthmaticus	RespiSim
Acute respiratory distress syndrome	High-fidelity mannequin and ventilator
Physiologically difficult airway	High-fidelity mannequin and ventilator
Pregnant patient in respiratory distress	High-fidelity mannequin and ventilator

Evaluation Methods

- Learners were evaluated on objective knowledge acquisition and subjective confidence levels before and after the course. The written evaluation can be accessed with the QR code:

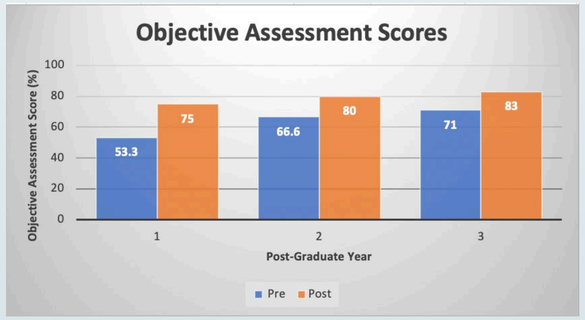
OBJECTIVE ASSESSMENT:
- Following the lecture series but before the simulation sessions, learners were asked to take a six-question multiple-choice assessment focusing on the principles of safe and effective ventilation.
- After the simulation session, learners were asked to take the same multiple-choice assessment.
- All post-graduate (PG) years received the same pre- and post-tests for objective evaluation.
- Pre- and post-tests were separated and average score for the entire cohort calculated. Then, scores were separated by PG year and averaged. Pre- and post-average scores for the cohort and separated by post-graduate year were compared by a Wilcoxson Rank Sum Test. .

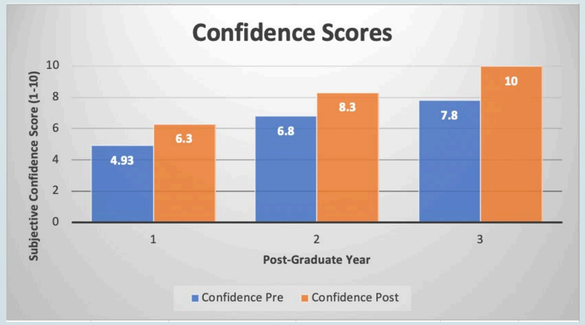
SUBJECTIVE ASSESSMENT:
- Following the lecture series but before the simulation sessions, learners were asked to rate their confidence in the following principles on a scale of one (Not at all confident) to ten (Very confident):
  - Ventilator management in the ED
  - Blood gas interpretation and application
  - MV in a patient with restrictive pathology
  - MV in a patient with obstructive pathology.
- The average score across all four principles was used for analysis. Pre- and post-assessments were separated and average score for the entire cohort calculated. Then, scores were separated by PG year and averaged. Pre- and post- average scores for the cohort and separated by post-graduate year were compared by a Wilcoxson Rank Sum Test.

Results

- While not reaching statistical significance, residents at all post-graduate levels showed a trend toward increased knowledge acquisition and confidence scoring following introduction of this novel curriculum.

Figure 1: Pre- and post-evaluation results. (A) Results on the objective assessment by post-graduate year before and after the course. (B) Subjective confidence scoring by post graduate year before and after the course.





Discussion and Conclusion

- Composite data analysis and analysis by PG year shows a trend toward increased knowledge acquisition and confidence scoring following introduction of this novel curriculum.
- The largest improvement in knowledge scores in PGY-1 residents supports early introduction of MV curricula into EM residencies.
- Continued improvement in PGY-3 residents in both knowledge and confidence scores supports longitudinal education in MV over the course of residency.

Challenges and Limitations

- Lectures and simulation sessions were temporally separated by several months, making it difficult to directly apply material from lecture to the simulation.
- Residents taking the evaluation may not have been present at the lectures or present at all the simulation sessions.
- Simulation groups included learners of all PG-years as well as medical students. Differing confidence and educational levels may have limited some individuals' ability to actively participate in the simulation.

Future Plans

- This curriculum can be adapted for use by the Main Campus and Fairview internal medicine residencies as part of their medical intensive care education.
- There are plans to adapt the course for EM attending physicians with the goal of increasing physician comfort with MV and LPV utilization at our institution.
- There is discussion regarding collaboration with the Ohio Chapter of the American College of Emergency Physicians to offer this course to emergency physicians regionally and nationally.

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