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Responding to a Respiratory Complication in the Recovery Room: A Simulation Case for Anesthesiology Students

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B. History and Physical Examination.docx
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All appendices are peer reviewed as integral parts of the Original Publication.

Abstract

Introduction: Postoperative respiratory complications have multiple etiologies, are commonly occurring, and are potentially life-threatening complications of anesthesia. Adverse outcomes associated with respiratory complications are a leading cause of injury-related malpractice claims in anesthesiology. Appropriate response to respiratory complications in the postanesthesia care unit (PACU) involves early intervention, development of a differential diagnosis, and an organized approach to respiratory support and patient disposition. **Methods:** This simulation is designed for medical students, student nurse anesthetists, and junior resident physicians rotating clinically in anesthesiology. It is designed as a 1-hour, small-group, simulation-based learning activity centered upon a single patient encounter. It focuses on a postoperative encounter occurring shortly after a patient arrives in the PACU. The patient is recovering from a prolonged emergent upper abdominal surgery using an anesthetic associated with increased risk of respiratory complications, and has multiple risk factors for postoperative respiratory complications. This scenario is easily reproduced on modern simulation mannequins without specialized programming. The patient's vital signs are displayed and remain within normal limits, with the exception of the oxygen saturation and heart rate, which must be adjusted during the exercise. **Results:** Learners provided evaluations of their experience with this simulation, and these appraisals and comments have been unanimously positive. **Discussion:** We employed this exercise using an anesthesiology resident physician to proctor and debrief, a simulation technician to program and run the model, and a faculty anesthesiologist to mentor each session. We used this simulation case as an educational opportunity for medical students rotating clinically in our department.

Keywords

Respiratory Insufficiency, Residual Neuromuscular Blockade, Postoperative Respiratory Complications

Educational Objectives

At the end of this simulation, the learner will be able to:

1. Identify signs and symptoms of respiratory complications in the postanesthesia care unit (PACU).
2. Identify mechanisms of respiratory support for patients experiencing respiratory complications in the PACU.
3. Develop a differential diagnosis for respiratory complications in the PACU with attention to reversible causes.
4. Identify patient-, surgery-, and anesthetic-associated risk factors for postoperative respiratory complications.
5. Correctly identify pharmacologic agents and dosing for reversing neuromuscular blockade and opioid overdose.

Introduction

This simulation is designed for learners who have had exposure to anesthesiology and the perioperative process and who would be reasonably expected to respond to respiratory complications during the perioperative time period. It is ideally suited for medical students, student nurse anesthetists, and junior-level resident physicians rotating clinically in anesthesiology. The simulation is relevant to any learner exposed to patients during the perioperative process, from preoperative evaluation and testing to postoperative care of the surgical patient. Inclusion of nursing personnel in this simulation would create a worthwhile multidisciplinary exercise and is encouraged when feasible.

This simulation is based upon the presentation of a major diagnostic dilemma commonly encountered in the practice of anesthesiology and is intentionally written so that it can be adapted to any of the major postoperative respiratory complications. The purpose of this activity is to supplement required reading assignments with a clinical scenario that encourages learners to synthesize their command of the knowledge into a well-organized approach to intervention and treatment of a potentially life-threatening situation commonly seen in clinical practice. The simulation is designed to reinforce the learner's understanding of risk-factor identification and mitigation, as well as the respiratory effects of medications commonly used in the practice of anesthesia, and to teach the importance of an organized approach to airway support and treatment of respiratory complications in the postanesthesia care unit (PACU).

This exercise should be delivered as a 1-hour, small-group simulation to medical students toward the end of a 1-month clinical rotation in anesthesiology. The learners are expected to have completed basic reading assignments from *Morgan & Mikhail's Clinical Anesthesiology*.[1] Specifically, this exercise reinforces the information presented in chapters 8-12 and 23-24.[2-8]

Respiratory complications in the PACU occur as a combination of major unanticipated ventilation problems, including hypoxemia (hemoglobin oxygen saturation < 90%), hypoventilation (respiratory rate < eight breaths per minute or arterial carbon dioxide tension > 50 mmHg), or upper airway obstruction (laryngospasm or stridor), that require a physical or pharmacological intervention.[9,10] Respiratory complication frequency varies highly amongst institutions but remains a significant source of patient morbidity and mortality leading directly to increased length of hospital stay and cost of care.[9-14] Adverse outcomes related to respiratory complications have been analyzed and found to be a leading cause of injury-related malpractice claims within the anesthesiology specialty.[9,11,13] The etiology of the majority of respiratory complications in the PACU can be divided into three major categories: patient-related, surgery-related, and anesthesia-related. Proper management of a patient experiencing respiratory complications in the PACU involves a wide range of support and interventions depending upon the clinical circumstance, and it is vital that anesthesia providers be well versed in response and treatment of these complications, with special attention paid to reversible causes.

Several studies have evaluated the significance of patient-related comorbidities on the incidence of respiratory complications during the perioperative period. Patients with asthma and chronic obstructive pulmonary disease are at highest risk for postoperative respiratory complications.[10,12,14-16] There is significant evidence that congestive heart failure, advanced age, male gender, American Society of Anesthesiologists Classification of 2 or greater, and functional dependence are independent patient risk factors for postoperative respiratory complications.[12,15,16] Impaired sensorium, weight loss, smoking, alcohol use, a serum albumin level less than 35 g/L, and a blood urea nitrogen level greater than 21 g/dL are also patient-related comorbidities associated with an increased risk of postoperative respiratory complications.[10,12,15,16] Evidence suggests that identification and optimization of patient-related risk factors prior to surgery can reduce the incidence of postoperative respiratory complications.[12]

A number of studies have identified surgery-related factors that increase the risk of developing postoperative respiratory complications. Open aortic aneurysm repair, thoracic surgery, upper abdominal surgery, neurosurgery, head and neck surgery, vascular surgery, emergency procedures, and procedures lasting more than 4 hours are all associated with an increased risk of postoperative respiratory complications.[8,10,12,15-18] These types of surgery are associated with postoperative respiratory compromise even in patients without significant comorbidity.[8,10] Preoperative patient optimization, proper intraoperative management, and aggressive postoperative therapy modalities are important in reducing the incidence of postoperative respiratory complications associated with these types of surgery.[8,10,12,16-18]

General anesthesia with endotracheal intubation and mechanical ventilation has been demonstrated to impair pulmonary function, even in normal individuals, resulting in decreased postoperative tissue oxygenation.[8,10] General anesthesia and mechanical ventilation can result in a reduction in functional residual capacity of up to 50% compared to preoperative values.[10] Pulmonary atelectasis is a common occurrence in anesthetized individuals with an incidence of 85% to 90% even in healthy adults. Evidence indicates that atelectasis, in combination with alveolar hypoventilation and ventilation-perfusion mismatch, is the core mechanism responsible for postoperative hypoxemic events in the majority of patients in the PACU.[10] Other anesthetic factors that affect the risk of postoperative respiratory complications include the effects of anesthetic drugs, most notably, residual neuromuscular blockade, opioids, and sedative agents. The appropriate use of anesthetic and analgesic techniques, when combined with meticulous postoperative care, clearly influences pulmonary outcomes in the PACU.[8,10,16-18]

Studies have indicated that residual neuromuscular blockade is an important factor that impacts the incidence of postoperative respiratory complications.[1,6,10,14,16-21] Residual neuromuscular blockade can produce postoperative respiratory complications via multiple mechanisms such as the attenuation of hypoxic ventilatory response, upper airway obstruction, pharyngeal dysfunction, and impaired respiratory muscle strength. These effects are directly related to the level of residual neuromuscular blockade as evidenced by measured train-of-four ratios such that the lower the train-of-four ratio, the more profound the deleterious consequences.[19,20] Studies have indicated that even small amounts of residual neuromuscular blockade, in addition to other respiratory depressant anesthetic and analgesic agents, combined with patient- and surgery-related factors, can lead to critical respiratory events in the PACU.[1,6,10,14,16-20] It is imperative that anesthesia providers recognize the importance of residual neuromuscular blockade as a reversible cause of postoperative respiratory complications and that they be well versed in responding and treating this relatively common phenomenon.

Methods

In this simulation (Appendix A), the PACU nurse places a call to the participant to report the condition of a patient in the PACU. The patient originally presented to the emergency room with a small bowel obstruction secondary to an incarcerated ventral hernia and underwent an emergent exploratory laparotomy, extensive lysis of adhesions, small bowel resection, and ventral hernia repair. The patient has comorbidities, underwent a procedure, and had an anesthetic, all associated with increased risk of postoperative respiratory complications. The patient arrived in the PACU in satisfactory condition, awake and hemodynamically stable, and had an oxygen saturation of 98%. After approximately 20 minutes, the patient appears more somnolent, he becomes mildly tachypneic, and his oxygen saturation slowly decreases to 90%, prompting the PACU nurse to increase the delivery of supplemental oxygen via nasal cannula to 6 L per minute from 3 L per minute. This supplemental oxygen increase results in an increase in his oxygen saturation to 92%, prompting concern from the PACU nurse who decides to call the participant for assistance.

If asked, the patient relates that he does not feel like he is breathing and he cannot breathe deeply. There are no other hemodynamic or physiologic derangements upon initial presentation, and the patient is somnolent and tachypneic but otherwise normal and stable.

Throughout the exercise, the facilitator relates to the team any responses from questions addressed to the patient during examination (patient history and physical examination, Appendix B). The patient responds appropriately when stimulated but otherwise falls asleep when not being directly questioned. The patient has no complaints of pain, nausea, or pruritis. The patient never complains of being short of breath directly but will continually relate that he does not feel like he is breathing or able to breathe deeply.

The patient's compliance to requests for deep breathing and coughing is lackluster and does not result in significant improvement. The patient remains asleep when not being directly stimulated, but is oriented and appropriate to direct questioning from the team. The facilitator should limit the patient's responses to short answers, mainly in the form of "yes" or "no."

The participants should respond to the bedside to evaluate the patient rather than evaluate the patient by report from the PACU nurse. Upon participant arrival, the patient is moderately tachypneic and slowly becomes more somnolent as time moves along. The patient's oxygen saturation slowly decreases from 92% down to 88% on 6 L of supplemental oxygen via nasal cannula. The patient does not display signs or symptoms of acute respiratory failure but does become more and more difficult to arouse and upper airway obstruction becomes more prominent.

Participants should develop a differential diagnosis for respiratory insufficiency in the PACU so that they can formulate a plan for intervention and treatment. This differential diagnosis should include pneumothorax, pulmonary edema, atelectasis, bronchospasm, abdominal splinting, opioid overdose, and residual neuromuscular blockade as a potential causes of the patient's hypoxemia. Participants should work to identify the mechanisms involved with this patient.

Participants should recognize the patient's need for additional respiratory support. Participants should place the patient in an upright position and encourage deep breathing and coughing. Participants should recognize the need to increase the delivery of oxygen by changing from nasal cannula to either an open mask, nonrebreather mask, or bag-valve mask, which support oxygen delivery rates in excess of 6 L per minute. Participants should recognize the need to resolve the upper airway obstruction with noninvasive means such as oral or nasal airway insertion. The patient only slightly improves with these interventions and will remain tachypneic with an oxygen saturation increasing from 88% to 92% despite positioning, increasing oxygen delivery, and relieving the upper airway obstruction. The patient tolerates the noninvasive airway devices with only minor stimulation of his gag reflex, indicating his increasing level of respiratory insufficiency as time advances. This should prompt further investigation and intervention. The participants should consider bag-valve mask support of ventilation and call for the airway cart and assistance in case of the need for reintubation.

Presented with this clinical scenario, the participants should consider ordering a portable chest X-ray to evaluate for pneumothorax, pulmonary edema, and pleural effusion. Participants should order an arterial blood gas (ABG) result (Appendix F) to evaluate the respiratory insufficiency. The chest X-ray (Appendix G) is remarkable for poor inspiratory effort and reduced lung fields but is negative for pneumothorax, pulmonary edema, or pleural effusion. ABG demonstrates a primary uncompensated respiratory acidosis.

Administration of Medication

- Albuterol: The participants should include bronchospasm in their differential diagnosis. The patient demonstrates no evidence of wheezing, retractions, or complaint of chest tightness. The patient however is tachypneic, hypoxemic, and complaining that he feels he is not breathing. A dose of albuterol to treat bronchospasm is not the ideal intervention but is a reasonable consideration given the scenario. If given, it will result in a slight increase in heart rate without a change in the respiratory component. Albuterol in this exercise should be dosed via unit dose inhaler and the patient should receive two puffs.
- Naloxone: The participants should include opioid overdose in their differential diagnosis. The patient is tachypneic with shallow respirations and his pupils are normal and reactive. The patient however is somnolent with respiratory insufficiency. A dose of naloxone is not the ideal intervention but is a

reasonable consideration given the scenario. If given, it will not improve the patient's level of consciousness or oxygen saturation. Naloxone in this exercise should be dosed via IV, and 0.04-0.08 mg would be appropriate.
- Neostigmine and glycopyrrolate: The participants should include residual neuromuscular blockade in the differential diagnosis. The patient is tachypneic with shallow breathing and hypoxemia and carbon dioxide narcosis. This is suspicious for residual neuromuscular blockade and is supported by the lack of reversal agent given at the end of the procedure. This is the intervention of choice in this case. Dosing of neostigmine and glycopyrrolate is via IV and 5 mg and 1 mg are the appropriate respective doses. If given, it will result in significant patient improvement within 5 minutes and resolution of the respiratory insufficiency and hypercarbia within 15 minutes. The patient's somnolence resolves as the carbon dioxide level returns to normal.

Intubating the patient in the PACU is not a preferred intervention. The patient is somnolent but responds to stimuli and has resolution of his upper airway obstruction with noninvasive interventions. Participants could choose to intubate the patient, which should prompt some discussion on the subject during the debriefing.

Facilitators can directly influence the flow of the scenario by controlling the speed of physiologic changes and patient responses to interview questions and interventions.

Equipment and Environment
This simulation can be performed in any accommodating location and requires no special room or facility features. In our facility, this exercise is carried out in our simulation education center in a room similar to our actual PACU. The model, bed, monitors, and equipment are available in the room, while the programming and monitoring of the scenario are accomplished via video feed and remote control. However, the scenario is simple enough that remote control and video are not required for successful implementation; the scenario is easily reproduced on modern simulation mannequins without specialized programming of any kind. In our institution, we use the Laerdal SimMan 3G simulation model with Phillips monitor for this exercise.

The mannequin should be positioned supine on a gurney similar to those used at the local facility. The patient should have a dressing placed over what would be an upper midline abdominal incision, and this dressing should be clean, dry, and intact. The patient should be dressed in a hospital gown and lying on the gurney covered in a hospital sheet and blanket as is customary in the facility recovery room. The patient should have a single peripheral IV with either lactated ringers or plasmalyte infusing at roughly 200 mL/hr. The patient should be connected to ECG, pulse oximetry, and noninvasive blood pressure monitoring. Supplemental oxygen should be delivered initially by nasal cannula at a rate of 6 L/min.

At least one stethoscope must be available for the learners to use, as well as a flashlight for checking the pupillary light reflex. An open face mask, a nonrebreather mask, and a bag-valve mask unit with oxygen tubing and wall connectors are required for this case. Oral and nasal airways of various sizes and tongue blades should be available, and although the patient in this scenario should not require reintubation, it is advisable that the equipment be available in case the team elects to intubate. A typical PACU airway cart, which should be identical in contents to the airway carts in use at the facility PACU in order to accurately create the clinical scenario and interventions, should also be made available for learners. Four medications are likely to be used during this simulation exercise and should be provided when requested by the team: albuterol, naloxone, neostigmine, and glycopyrrolate. Syringes, blunt needles, and alcohol prep pads also need to be available for drawing and delivering the medications through the IV.

Personnel
This simulation learning exercise is extremely flexible depending upon the number of participants. This case can be implemented using a single actor, a single participant, and a single facilitator. The number of

participants can be increased without detriment to the exercise. Roles for this simulation activity can be adjusted to accurately reflect the PACU staffing model in the local facility, and involvement of PACU nursing staff can add to the realism and value of this exercise as a multidisciplinary team-building activity. Roles in this activity can be played by faculty physicians, resident physicians, certified registered nurse anesthetist staff, nursing staff, or medical students.

The single actor in this educational simulation exercise is the PACU nurse, who initiates the exercise by calling the participants for assistance with the patient. The PACU nurse is primarily responsible for requesting help from the participants, explaining the clinical scenario to them, and providing additional information requested by the participants such as the patient's past medical history, operative course, and anesthetic record. The PACU nurse assists with the requests made by the participants in response to the scenario and may also make observations as needed to stimulate case progression. All of the requested data are contained within the history and physical examination (Appendix B), anesthesia record (Appendix E), ABG result (Appendix F), and chest X-ray result (Appendix G). The PACU nurse can prompt the team with this documentation if the team does not request it as the case advances.

Assessment

This simulation was designed as a learning activity for students rotating clinically in anesthesiology. With that design in mind, the participant assessment was developed based upon team achievement of all critical actions during the exercise. A dichotomous checklist of critical simulation exercise actions is provided in the critical action checklist (Appendix C) and should aid the facilitator in the evaluation process. Failure by the team to achieve any of the critical actions in the exercise should prompt focus on these areas in the debriefing process.

Debriefing

A postcase debriefing conference is recommended immediately following the end of the scenario. It should include a recap of the three main physiologic mechanisms of respiratory insufficiency (failure to ventilate, failure to oxygenate, failure to maintain a patent airway), their causes, and their treatment. The discussion covers patient-related factors increasing the risk of postoperative respiratory complications and techniques for mitigation of those risks. The discussion should also include the surgery and anesthetic factors that increase a patient's risk for postoperative respiratory complications and patient management modalities to reduce the incidence of these complications.

Consider including some of the following elements:

1. Open-ended questions by facilitator: Consider beginning the session with a question to the primary participant about how he/she felt the scenario went. This often leads to extensive participant-led discussion that will touch on many of the major issues in the case. Invite any secondary participants and observers to comment constructively about the case.
2. Brief didactic review: The facilitator should review the assessment tool checklist to identify any critical actions that were missed by the team so that knowledge and action gaps are addressed in the debriefing. A PowerPoint presentation (Appendix D) that presents in didactic format the relevant knowledge, background information, and explanation of critical actions involved with this case is provided. The facilitator can adapt this presentation to fit the needs of the activity participants and chosen scenario.
3. Formal participant evaluation: We do not use this case for formal evaluations, and we have no standardized form or format for such feedback. The case can easily be adapted to the standardized evaluation method at your institution using the educational objectives.

Results

This simulation case has been delivered on multiple occasions in our institution using an anesthesiology resident physician to proctor and debrief, a simulation technician to program and run the model, and a faculty anesthesiologist to mentor each session. We have used this case as an educational opportunity for medical students rotating clinically in our department; however, we have had the opportunity to run this simulation with resident physicians as well. Facilitators have had no difficulty adhering to the prescribed protocols in multiple simulation runs.

Group performances during the simulation are monitored in real time by the proctor using the critical action checklist as a guide for completion of the objectives. In our experience with this module, participants thought out loud, proposed explanations for the changes in the patient's condition, suggested interventions, and implemented therapeutic intervention after group agreement. All groups met the majority of the objectives listed in critical action checklist and did a good job of responding to and assessing the patient, performing a brief history, conducting a pointed physical exam, and reviewing the patient's history of present illness, general history, and physical examination. Most groups adequately performed basic airway interventions, such as identification and implementation of mechanisms for increased oxygen delivery. A significant number of groups did miss certain basic critical actions, such as an assessment of the patient's strength, recognizing signs of upper airway obstruction, and implementing an intervention such as oral or nasal airway.

After having initially intervened and improving the patient's oxygenation, as noted by stable oxygen saturation of arterial blood, better performing groups began to formulate a differential diagnosis and order lab tests. Groups consisting of resident physicians tended to have a more organized and comprehensive differential diagnosis list than those groups containing only medical students. Items that groups often missed in their differential diagnoses included atelectasis, abdominal splinting and residual neuromuscular blockade. Some groups required pointed questioning from the nurse in the simulation concerning the implementation of undesirable actions such as reintubating the patient. Groups have largely avoided naloxone use given the clinical scenario, but frequently chose to administer albuterol. Groups equally ordered and reviewed ABG analysis, but not all groups thought to order a chest X-ray. We regularly noticed that groups consisting of medical students would arrive at the correct diagnosis of residual neuromuscular blockade but did not know the correct dosage of reversal agents. This problem was compensated for by either allowing them to look it up or to have the nurse in the simulation case offer the suggested dose.

Of note, some participants described feeling limited in their actions as they did not understand well enough the boundaries or capabilities of the simulation model. They suggested a short presession introduction to the sim model and the extent and limitations of their interaction with it. A group proposed the implementation of continuous positive airway pressure/bilevel positive airway pressure, which was an intervention we did not specifically address in the critical action checklist as it is typically not a treatment modality used in the PACU. We compensated by informing any group requesting this that the nurse must call respiratory therapy and have the machine delivered to the PACU, which takes time.

Learners were not officially evaluated on their performance during this simulation, and this was intentional. Our department uses these simulation exercises in order to augment the instruction learners receive during clinical care of patients in the operating room. It was our desire to provide an environment of active learning that offered the learners an opportunity to work closely with resident and attending physicians in a setting free of performance expectations such that learners were more apt to surrender to the simulation environment in a positive manner. Learners were asked to comment and rate the simulation exercise experience on their official evaluation of the clinical rotation within our department. These evaluations were conducted using our electronic evaluation system. Evaluations and comments are reviewed monthly and have been unanimously positive, and the feedback offered has been insightful and constructive.

Resident physicians were also asked to evaluate the simulation exercise experience. The department requested that resident physicians evaluate and comment on their experience in leading the simulation exercise and in delivering the formal didactic session so that we could improve individual exercises and the program.

Resident physician performance feedback was given after the completion of each session by the mentoring faculty. The intent was to offer constructive criticism and instruction in order to improve the resident physician's teaching and instructional delivery skills.

Discussion

Each simulation exercise that we developed underwent careful consideration for its value to the profession and potential for positive impact upon learners prior to submission for peer-reviewed publication. Three primary objectives motivated the research, development, and implementation of these simulation exercises within our institution.

First, we wished to foster and promote cooperative scholarship, education, and teaching between our clinical department and the school of medicine. The development of these exercises has opened an entirely new academic bridge between the school of medicine and our clinical department. We began with an idea and an interested medical student that volunteers for the project. We then matched that medical student with a resident physician and faculty member within our residency training program to form a team that accepts responsibility for the completion of the project. In this manner, we were able to instruct and mentor our medical students and resident physicians through the literature search process. As the projects were developed, medical students, resident physicians, and our faculty further honed their abilities in the scientific writing process. As these exercises were submitted for peer-reviewed publication, our medical students, resident physicians, and faculty became more experienced with the process of scientific literature publication and ultimately gained recognition for their effort.

Second, these exercises have been implemented as a means to augment the clinical experience that medical students receive when rotating electively within our department, to expand upon the conventional teaching methods that have been historically employed, and to foster an environment of active learning. Reviews of the elective rotation in our department identified medical students' desire for expansion of active-learning opportunities in the form of both skills labs and hands-on instruction in the technical aspects of our specialty. Medical students related to us that the time and performance pressures of the operating room were so great that their opportunities for technical and procedural instruction were limited. Implementation of these exercises was met with enthusiasm from our medical students. Students reviewed the elective rotation using our electronic evaluation system, and specifically commented that the simulations and dedicated time with resident and attending physicians in the simulation lab to the was valuable to the development of procedural skills and performance.

Lastly, we developed and implemented these exercises as a method of academic career development for our resident physicians and junior faculty. Each month, one of our resident physicians chose one of our simulations to present to the rotating medical students. The resident physicians worked with a faculty member to prepare and present the simulation exercise. In this manner, our resident physicians had the chance to develop their teaching skills with faculty mentorship and were given the opportunity and responsibility for formal teaching. The resident physician received feedback in the form of medical student comments on the rotation evaluation as well as direct feedback from their faculty mentor. This also benefited our faculty in the areas of academic development and mentorship skill improvement.

Overall, the addition of this simulation to our didactic exercises has been quite positive. Participants related that the simulation was challenging, appropriate to their level of training, and relevant to clinical rotation in our department. Most participants felt as if they performed well in their assessment and therapeutic interventions, but admitted that they had never encountered an actual case of residual neuromuscular blockade. They felt that this simulation would help them more appropriately respond to respiratory complications in the PACU. We specifically reinforced basic airway interventions to improve upper airway obstruction and development of a comprehensive deferential diagnosis, and this emphasis has been well received.

Group dynamics had an impact upon the simulation. We intentionally avoided assigning a group leader in this scenario so that it more closely mirrored clinical reality. Proctors and mentors have all noted that groups that self-identify a leader and rely upon that leader for delegation and organization tend to perform better compared to groups that did not. It has been interesting to note that most groups participating in this exercise would reflexively and silently assign the role of group leader to the most senior-level participant. This default selection process was more pronounced when medical students participated with residents; however, even amongst pure medical student groups, the more senior students tended to end up as group leaders.

Many simulations are of a catastrophic nature and require immediate and sometimes invasive interventions. It is clear from our implementation of this exercise that participants have become accustomed to rapidly responding, performing an intervention and seeking immediate feedback to the positive or negative consequence of that intervention. This simulation differed significantly in that the case progressed slowly and interventions took time to demonstrate results. The time to onset of activity after the administration of the reversal agent in this case was 5 minutes (10-15 minutes in real-life situations), which is a relatively long time in a simulation case. We found that because participants were not seeing instant results or positive feedback that they began to think that their intervention was either incorrect or ineffective leading them to rush to decide on further interventions. We time-compressed this simulation to accommodate for some of this; however, we feel that this has been important in teaching participants the value of patience and vigilance in the clinical arena.

Participants have noted some technical limitations with our specific simulation model. First, questions directed toward the patient in this case were responded to directly by our simulation technician who is running the program from the same room. To aid in realism, we recommend having the simulation programming and operator in a separate control room and provide the responses through the mannequin microphone. Secondly, there were technical difficulties in creating and sustaining appropriate upper airway obstruction sounds from the simulation model. These sounds waxed and waned, which by report from some groups contributed to participant uncertainty of the severity of the level of upper airway obstruction, or if it had resolved following intervention. Controlling extraneous noise in the simulation lab can improve this problem.

We believe this simulation is a useful tool to aid in the training and experience of students as they rotate clinically through our department. We implemented this exercise in regular rotation with students in our department with positive results. There were minor technical limitations in its implementation and encouraging participant patience and vigilance was at times challenging; however, the exercise easily met all of the objectives, participants found it valuable, and it fostered appropriate response to a commonly occurring clinical scenario.

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Ethical Approval

Reported as not applicable.

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