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Development of High-Fidelity Simulations for SRNAs: Airway Fire and Venous Air Embolism

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Executive Summary

Introduction of the Problem

Certified registered nurse anesthetists (CRNAs) must quickly recognize and appropriately treat rare lethal complications in a high-stress environment. Despite three years of training and previous experience as a nurse, student registered nurse anesthetists (SRNAs) often do not experience high-risk emergencies such as airway fire and venous air embolism (VAE) (La Cerra et al., 2019). Approximately 90 to 100 surgical fires occur annually, most commonly in the airway; yet many CRNAs never experience an airway fire in their career (ECRI, n.d.; Higgins Roche, 2018). Similarly, a CRNA might not encounter a VAE due to its low incidence and potential for misdiagnosis (McCarthy et al., 2016). If a SRNA's first experience with an airway fire or VAE is in a clinical setting, there is an increased risk for errors. High-fidelity simulation can create low-incidence, high-mortality situations in a safe environment that allows students to learn with zero risk. This project involved developing and implementing two high-fidelity simulation scenarios for airway fire and VAE for SRNAs enrolled in the Nurse Anesthesia program at Southern Illinois University Edwardsville (SIUE). The project's goal was to provide simulations that will be incorporated into the curriculum to teach SRNAs how to work as a team during emergencies and effectively act in real-life scenarios.

Literature Review

Simulation improves teamwork, critical thinking and assessment skills, procedural competencies, knowledge, and confidence and helps participants identify areas of weakness and knowledge gaps (Carey & Rossler, 2022; Harrington & Simon, 2022). Simulations have different levels of fidelity or realism, which correlates with the realism felt by the participants (Carey & Rossler, 2022). The equipment, environment, and simulation scenario influence the three levels

of fidelity: low, medium, and high (Carey & Rossler, 2022). High-fidelity simulation has a high level of realism that involves a mannequin with different variables that can be controlled and manipulated during the simulation, such as blood pressure, heart rate, lung sounds, pulse oximetry, talking, and eye movements (Seropian et al., 2004). A simulation can be considered high-fidelity based on three different types of fidelity: physical, psychological, and conceptual. The kind of fidelity can improve or deter learning, and each type can influence the other to add or subtract from the overall level of fidelity (Carey & Rossler, 2022). An overly complex scenario can overwhelm the student and deter learning. An error in physical fidelity is more accepted by participants than an error in conceptual fidelity (Carey & Rossler, 2022). Low and medium levels of physical fidelity can still create a high-fidelity simulation overall.

Simulation scenarios should represent real-life events to facilitate learning and reach educational goals (Harrington & Simon, 2022). Target learners, context, intended outcome and goals, level of fidelity, props, simulators, and patient population should all be considered when designing a scenario (Harrington & Simon, 2022). An instructor document of goals, objectives, case summary, ideal flow, anticipated learner mistakes, and tips keep the scenario running should be created along with a critical action checklist and technician document (Mills et al., 2018). A pre-brief to the simulation should be made to set expectations for the learner and orient them to the simulation environment and equipment (Harrington & Simon, 2022). The instructor must implement and lead post-simulation debriefing to explore and understand the stimulation's events, actions, thought processes, performance, and outcomes (Kolbe et al., 2015). It is essential that the debriefing is adequately conducted to avoid adverse learner outcomes.

The incidence of airway fires has declined due to the use of nonflammable halogenated inhalation agents, and many anesthesia providers have not experienced an airway fire in a

clinical setting (Akhtar et al., 2016). An airway fire occurs when the fire triangle is completed, and the anesthetist can help control each component to prevent an airway fire. Once an airway fire occurs, the anesthesia provider has 6 seconds to recognize and eliminate the fire before serious harm occurs (Higgins Roche, 2018). The provider must remain calm and perform specific tasks including removing the airway device, including discontinuing gas flow and pouring saline down the airway (Higgins Roche, 2018). The patient will need observation in the intensive care unit to receive further treatment depending on the severity of the thermal injury and carbon monoxide presence (Higgins Roche, 2018).

The incidence of VAE is challenging to determine due to the rarity and variations in presentation, but it remains a deadly complication of surgery (Brull & Prielipp, 2017). A VAE occurs when a negative pressure gradient between the environment and the patient's venous system entraps air into the bloodstream (McCarthy et al., 2016). Depending on the volume and speed of air entrainment, symptoms can range from a cough or zero symptoms to right-sided heart failure, stroke, and cardiovascular collapse (Gordy & Rowell, 2013; Yafen & Rice, 2017). Early detection by the CRNA can significantly decrease patient morbidity and mortality. The CRNA should immediately inform the surgeon to flood the surgical field to stop further air entrainment and administer 100% oxygen while supporting hemodynamics (Brull & Prielipp, 2017).

High-fidelity simulation improves students' clinical judgment, knowledge, and performance and can help them handle low-incidence, high-mortality clinical scenarios (La Cerra et al., 2019; Ayed et al., 2022). It is a safe and effective educational tool for improving overall knowledge, confidence, performance, and skills for SRNAs.

Project Methods

This project involved developing, implementing, and evaluating two high-fidelity simulations for nurse anesthesia students. The goal was to create two simulations that would help SRNAs prepare for airway fires and VAE by increasing participants' knowledge and confidence in managing future events related to airway fires and VAE. The simulations were created after a thorough literature review of high-fidelity simulation, airway fire, and VAE. After collaborating with the project stakeholder, the simulations were incorporated into the third-year SRNAs' curriculum at SIUE. Thirty students participated in each simulation, followed by a debriefing to discuss the critical components of each simulation scenario. Each SRNA completed a questionnaire to evaluate their knowledge, experience, and perceptions post-simulation. This project was submitted to the university IRB and approved for exempt status before implementation.

Evaluation

Few obstacles were encountered with project implementation. One limitation to the project was the small group size of 30 participants. This was a variable that could not be controlled because of the set class size. Another limitation was the inability to educate participants on the simulation topics beforehand and evaluate if our education was effective with a pre and post questionnaire.

The project evaluation consisted of a post-implementation questionnaire reviewed and approved by content experts, the project stakeholder, and the team leader. After the simulation and debriefing, the questionnaire assessed the participants' knowledge of airway fire and VAE with two content-based questions for each simulation topic. Six questions were included regarding overall simulation effectiveness, experience, and perception of the simulation using a

10-point Likert scale. The questionnaire was provided online with a QR code that participants scanned and completed after debriefing. Each evaluation was kept anonymous.

After implementing the two scenarios, all SRNA participants provided positive feedback. 100% of SRNAs answered the knowledge-based airway fire questions correctly, 97% correctly identified the earliest sign of VAE under anesthesia, and 57% identified the first step in treatment of a VAE. Based on the data from the Likert scale questionnaire and open-ended comment feedback, the SRNAS who participated rated the simulation as a positive and educational experience that will benefit them in practice. All questions were answered with Agree or Strongly Agree when asked about the effectiveness, experience, and perception of the simulations, indicating that SRNAs found the simulation helpful for future clinical experiences and improved their critical thinking and decision-making skills in the future.

Impact on Practice

This project will positively impact SRNAs and their decision-making and critical thinking skills in the clinical setting. The scenarios in this project are rare in clinical practice, and having seen them in the simulation setting increases the likelihood that SRNAs will recognize and treat these scenarios with confidence in practice. High-fidelity simulations are incorporated into the SIUE Nurse Anesthesia program every semester. The University can continue improving simulation experiences and scenarios to make them more realistic for students. Simulation is an excellent method for allowing students a safe space to practice scenarios they may encounter in their clinical experience and the real world. Simulation should be used to benefit students with their confidence in diagnosing and treating scenarios.

Conclusion

This project allowed SRNAs to experience airway fire and venous air embolism simulations before potentially experiencing these scenarios in clinical practice. Based on the feedback from the SRNAs who participated in this project, high-fidelity simulation makes SRNAs more comfortable and confident in recognizing and treating these scenarios in the clinical setting. Future recommendations include creating additional low-incident, high-risk emergency scenarios for SRNAs to improve recognition and treatment of these scenarios. Other recommendations include advancing simulation technology to make these scenarios more realistic.

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