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# Effectiveness of Virtual Reality in Anesthesia Machine Education

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## Executive Summary

### Introduction of the Problem

The anesthesia machine is an essential part of anesthesia practice, as it connects the patient to the provider and provides a constant stream of vital information. Therefore, the Certified Registered Nurse Anesthetist (CRNA) should be trained in how to utilize and troubleshoot the anesthesia machine to deliver high-quality patient care. Education about the anesthesia machine begins with Student Registered Nurse Anesthetists (SRNAs) by providing various learning opportunities. Studies show that multimodal teaching techniques improve learning outcomes (Philippe et al., 2020). The Southern Illinois University Edwardsville (SIUE) Doctor of Nurse Anesthesia Program (DNAP) has an immersive virtual reality simulation software called SIMVANA. SIMVANA allows SRNAs to virtually and safely interact with an anesthesia machine to develop the knowledge and skills necessary to perform an anesthesia machine checkout and familiarize students with machine functions. Currently, SIMVANA is not part of the DNAP course curriculum, thus limiting anesthesia machine learning opportunities. There is a paucity of current research involving virtual reality simulation for anesthesia machine education, which was the catalyst for this project. Therefore, this project aimed to determine the effectiveness of utilizing SIMVANA for first-year SRNAs to learn about the anesthesia machine.

### Literature Review

The literature review completed between June and December 2022 produced twenty-four research articles regarding immersive virtual reality simulation in anesthesia education and twenty-six articles regarding the anesthesia machine. There was a paucity of current literature addressing the issue of anesthesia machine checks and malfunctions. No research articles were found during the search that included both anesthesia machines and immersive virtual reality.

Anesthesia machines have advanced in complexity since the early 20th century. Today, healthcare facilities are using technologically complex anesthesia workstations that vary significantly by manufacturer. In 1993, the FDA established anesthesia apparatus checkout recommendations. In 2008, the American Society of Anesthesiologists (ASA) updated the U.S. Food and Drug Administration (FDA) recommendations to apply to all anesthesia apparatuses, with the purpose that anesthesia machine checkout protocols are now adapted to suit all types of machine designs and healthcare facilities (Brockwell et al., 2008). Anesthesia providers are responsible for thoroughly checking the anesthesia machine before the first case of the day, and additional checks must be completed before each anesthetic (Goneppanavar & Prabhu, 2013).

Intraoperative machine malfunction incidences are rare. However, machine malfunctioning can lead to adverse patient safety events and increased morbidity and mortality. Advanced technology has improved patient safety; however, modern anesthesia machines still malfunction (Goneppanavar & Prabhu, 2013). Approximately 35% of adverse event claims may have been avoided by a thorough machine checkout (Grüßer et al., 2020). The Fourth National Audit Project (2011) identified poor patient outcomes most commonly resulting from issues surrounding airway management compounded by a lack of preparedness. Another case report presented a scenario where the anesthesia machine failed intraoperatively, and all basic monitoring and ventilation patterns were lost. However, the anesthesia providers were vigilant and well-prepared with backup equipment (Aqil et al., 2014). These studies present a variation in preparedness that can be addressed with proper education. Aqil et al. (2014) recommends that all anesthesia providers participate in simulation scenarios related to equipment malfunction.

Virtual reality is a potential educational aid to engage active learners. Experience and knowledge retention are improved through the learning opportunities provided by virtual reality

(Philippe et al., 2020). Students who participated in virtual reality simulations report that it is fun and improves their confidence in clinical skill applications (Zafar et al., 2021). The use of virtual reality in medical education produces equivalent or better outcomes than non-immersive training (Mooney et al., 2022). Immersive virtual reality simulation has been successfully used to train regional anesthesia and rare anesthetic occurrences, such as an airway fire or a myocardial infarction (Lovquist et al., 2012; Zafar et al., 2021; Grottke et al., 2009). Providing rare anesthesia machine-specific simulation scenarios and allowing user response with system feedback reveals the student's knowledge through interaction with the machine (Mudumbai et al., 2010). Evidence suggests educators gain more knowledge about a student's level of skill mastery through virtual reality assessments over traditional paper exams (Singh et al., 2012).

Virtual reality offers an educational advantage by limiting geographic barriers to accessing ORs and reduces risks to real patients (Orser & Spadafora, 2022). Virtual reality can reduce the time commitment, reduce resource use from traditional simulation experiences, and limit inconsistencies between participant experiences (Merrick et al., 2020; Singh et al., 2012). There are limitations to implementing immersive virtual reality simulation education, including learner acceptance and participation, overcoming the learning curve for use, motion sickness, and wearing glasses (Philippe et al., 2020; Huang et al., 2020; Zafar et al., 2021).

**Project Methods**

This project involves implementing the SIMVANA anesthesia machine immersive virtual reality simulation software in the foundation anesthesia course NURS 529 – Orientation to Nurse Anesthesia Practicum at Southern Illinois University Edwardsville (SIUE). Thirty-one first-year student registered nurse anesthetists (SRNAs) participated in the non-experimental single-group study during the anesthesia machine labs in the Spring 2023 semester. Before implementation,

this project was reviewed by the SIUE Institutional Review Board (IRB) and deemed exempt from human subject research. Faculty involved with the development and completion of the project include the external stakeholder Dr. Kevin Stein, second reader Dr. Greg Jennings, and faculty lead Dr. Linda Sharpless.

**Evaluation**

Nurse Anesthesia students in their first year at Southern Illinois University Edwardsville (SIUE), were provided with an educational opportunity to use a virtual reality simulator to facilitate learning about the anesthesia machine during their scheduled lab course. Before teaching, students completed a pre-implementation survey (Appendix A), containing five Likert scale questions and two open-ended questions to understand the student's baseline comfortability with the anesthesia machine. Students were then taught how to use SIMVANA, and some students participated in hands-on experience while others watched the virtual environment to help facilitate learning. The SRNAs then completed a post-implementation survey (Appendix B), after interacting with SIMVANA. The post-implementation survey contained six Likert scale questions, five of which were the same as the pre-implementation survey; one Likert scale question was new, and two different open-ended questions that specifically addressed SIMVANA were added. Thirty-one pre- and post-implementation anonymous surveys were collected from the first year SRNAs. The survey results are in both authors' possession. After experiencing over five months of clinical and rotating through three clinical sites, an anonymous post-clinical Qualtrics survey (Appendix C), was emailed to the participants. Thirty-one post-clinical surveys were completed. Survey data was organized in an Excel sheet and analyzed with the Chart Expo add-in to quantify and depict the range of responses (Appendix D).

The results of the pre-implementation and post-implementation surveys revealed an improvement in decreasing anxiety surrounding the use of the anesthesia machine in clinical. However, the follow-up after attending clinicals did not reflect such anxiety-reducing impacts of SIMVANA. This deviation may reflect the general stress experienced by students early in their clinical training. After implementation, there was an improvement in having a strong understanding of the anesthesia machine. Additionally, confidence in performing an anesthesia machine checkout improved after experiencing SIMVANA. The post-clinical survey revealed that more students found SIMVANA to be helpful in performing the machine checkout in clinical than the few that did not find it helpful. The ability to troubleshoot anesthesia machine alarms and malfunctions increased between pre- and post-implementation survey results. However, after students experienced the anesthesia machine in a clinical setting, more students did not find that SIMVANA helped their ability to troubleshoot machine alarms. After implementation, all participants reported that they favored using SIMVANA to prepare for clinicals, and about one-fourth of the participants answered that they used SIMVANA since implementation in the post-clinical survey. Overall, most of the participants recommended utilizing SIMVANA to future cohorts to learn about the anesthesia machine before entering clinical.

The pre-implementation open-ended questions revealed that the students used a variety of methods to learn, and while many of those methods were technology related, none involved virtual reality simulations. The most effective learning style utilized by students was tactile learning, which immersive virtual reality provides. The post-implementation open-ended questions about what the students liked about SIMVANA included that it provided a realistic environment, was a low anxiety activity, and was a new form of educational technology. When

asked what students did not like about SIMVANA, they responded that they experienced motion sickness or dizziness during the implementation. Other concerns with SIMVANA reported by the students were the learning curve when first trying to use the SIMVANA controllers and headset and technological difficulties in using the software and accessories.

## Impact on Practice

Patient safety is a major priority in anesthesia practice. Proficiency with machine checkout and a strong knowledge of the components of the anesthesia machine will impact anesthesia practice and, therefore, improve patient safety. A more diverse range of students can be provided with learning opportunities through additional resources that vary from traditional resources for learning such as textbook reading and classroom lectures. Through simulation students learn timely responses to critical alarms, identifying malfunctions, and preventing adverse patient outcomes. Many students learn best through varying modalities; therefore, providing additional tools and resources for learning the anesthesia machine will enhance provider education. The findings of this project and continuation of providing experience with SIMVANA to the SIUE nurse anesthesia students can improve students' ability to use the anesthesia machine, thus creating more knowledgeable and prepared anesthesia providers.

## Conclusion

Overall, this study recommended using SIMVANA in future SIUE SRNA cohorts. Anesthesia machines are the major component between the provider and patient that ensure a safe system of maintaining and monitoring patient dynamics. Preparing SRNAs through multimodal training opportunities aimed at improving their ability to understand machine functions and how to address alarms can improve patient safety and decrease provider anxiety. There has been a demonstrated direct correlation between improved education through

simulation and reduction in stress surrounding anesthesia machine functions that will create safer anesthesia providers.

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