Video Simulation as an Educational Strategy to Increase Knowledge and Perceived Knowledge in Novice Nurse Anesthesia Trainees

Rachel A. Kozlowski
DePaul University, RACHELANN44@GMAIL.COM

Jennifer A. Kurdika
DePaul University, kudirka2@gmail.com

Video Simulation as an Educational Strategy to Increase Knowledge and Perceived Knowledge in Novice Nurse Anesthesia Trainees

Rachel Kozlowski & Jennifer Kudirka

DePaul University, Chicago, Illinois

Table of Contents

Appendices

Abstract

Background: Video simulation is gaining popularity as an alternative method of teaching and can play an important role in nurse anesthesia education.

Objectives: The purpose of this study is to analyze the effects of an educational video simulation on acquisition of knowledge and perceived knowledge of anesthesia induction in novice nurse anesthesia trainees (NATs).

Methods: A single group pre-test post-test design was used to compare knowledge and perceived knowledge on standard and rapid sequencing induction of anesthesia. Pre test scores on knowledge and perceived knowledge were obtained and followed by a viewing of pre-recorded video simulation on standard and rapid sequence of anesthesia induction. Post test scores were obtained immediately after viewing the complete pre-recorded video simulation. The convenience sample included volunteers who were second year NATs at NorthShore University HealthSystem School of Nurse Anesthesia.

Results: Twelve NATs participated in the single group pre test-post test design. The Wilcoxon signed ranks test revealed all statistically significant score differences in all five ordinal outcomes for perceived knowledge standard induction (all p values = or < 0.05) and perceived knowledge rapid sequence induction (all p values = or < 0.05). The Wilcoxon signed ranks test and paired samples t test revealed statistically significantly difference mean scores on NATs' knowledge for both standard induction ($Z = -2.944$; $p = 0.003$) and rapid sequence induction of anesthesia ($t = 4.711$; $p = 0.001$), respectively.

Conclusions: Viewing a video simulation on the sequence of standard and rapid sequence anesthesia induction increased both knowledge and perceived knowledge among novice NATs. This pilot study provides preliminary evidence that there is a role for video simulation education in the curriculum of nurse anesthesia programs. There is a need for more research to provide more evidence on the efficacy of video educational strategy.

Key words: Simulation, video, students, learning, anesthesia induction

Introduction

Background and Significance

Achieving clinical competence is a top priority for future anesthesia providers. Many aspects of anesthesia practice require technical skills traditionally taught in lecture format. The educational program for nurse anesthetist trainees (NATs) incorporates a rigorous didactic component followed by a transition to clinical residency. Clinical skill acquisition during the formative years is crucial to a student's future practice. According to Lee et al. (2016), the acquisition of clinical skills can be challenging if opportunities to experience clinical procedures are not available. Technology based learning can supplement conventional teaching to prevent this problem. This alternative method of teaching gives another resource for the novice NAT to utilize in order to achieve clinical competence.

The increased use of technology has created several alternative methods of teaching available to be incorporated into curriculums. One newly popular alternative method of teaching is the use of educational videos (Sharpnack, Goliat, Baker, Rogers, & Shockey, 2013). Web-based video simulation has been described as using interactive videos to mimic the reality of a clinical environment or situation (Sharpnack et al., 2013). Technology-based learning can enhance the traditional strategies of learning already implemented (Lee et al., 2016). Sharpnack et al. (2013) also argue that offering audio or visual educational strategies creates a greater potential for reaching various learning styles of students and improving educational outcomes. Since procedural skills are often difficult to learn when presented in a list format, the educational videos teach the skill in a way that is more engaging for visual learners.

While research supports the use of video simulation in education, evidence is lacking for the use of video simulation in anesthesia education. Both conventional teaching methods and the use of simulation have the potential to educate the anesthesia provider on technical skills, which include clinical knowledge and procedural skills (Szlachta, 2011). Video simulation can play an important role as an alternative method of teaching a technical skill such as the sequence of induction. NATs in the preclinical phase have no previous exposure to the steps of induction of general anesthesia. Having reference tools like educational videos, which demonstrate the sequence of anesthesia induction, may increase knowledge in the nurse anesthesia trainee before they perform the skill.

Problem Statement

Despite known effectiveness of video simulation as an adjunctive teaching strategy, few studies have investigated its role to increase acquisition of knowledge and perception of knowledge among NATs. Furthermore, the use of video simulation, specifically the induction of anesthesia in novice NATs, has not been thoroughly investigated.

Purpose of the Study

The purpose of this study was to analyze the effects of an educational video simulation on acquisition of knowledge and perceived knowledge in novice NATs utilizing a single group pre test-post test design. A simulation video was created to teach the sequential steps of induction. This technical skill was chosen because it incorporates several components of the practice of anesthesia and allows the novice NATs to apply classroom knowledge to an important clinical procedure. This video served as a teaching tool to transform didactic knowledge into clinical competence.

Clinical Question

The following questions were proposed:

- Does viewing a video simulation of the induction sequence of anesthesia increase knowledge in novice NATs?
- Do novice NATs report a greater perception of knowledge after viewing a video simulation?

Conceptual Framework

Clark and Paivio's dual coding theory (Clark & Paivio, 1991) explains the benefit of using video simulation education to supplement traditional learning methods and enhance knowledge. This theory describes how the process of learning abstract information can be enriched by imagery and visualization (Chi, Pickrell, & Riedy, 2014). The dual coding theory proposes that humans have two separate but interconnected pathways to cognitively process information. The first pathway processes language, while the second pathway processes visual imagery (Hartland, Biddle, & Fallacaro, 2008). The dual coding theory postulates that, "use of visualization enhances learning and recall, in no small part because images and words are processed at different sites in the central nervous system" (Hartland et al., 2008, p. 195-196). This theory argues that information is more effectively retained and retrieved when it is dually processed through the interconnected pathway of both the linguistic and visual systems (Hartland et al., 2008).

Hartland et al. (2008) employed the dual coding theory in testing the hypothesis that video simulation education will amplify cognition compared to written/lecture information alone. This alternative teaching tool was chosen due to the belief that "video demonstration, unlike words, may have the ability to enliven abstract concepts, demonstrate real-world applications of complex principles, motivate the learner, organize thoughts and actions of highly cognitive processes, and heighten learner attention and interest" (Hartland et al., 2008, p. 197). Since the nature of anesthesia education involves teaching students to perform risky interventions, such as correctly placing a breathing tube or injecting powerful medications intravenously, on actual patients, video based learning can prepare students to initially learn in a risk-free environment (Hartland et al., 2008). Expanding on this concept, a video simulation on the induction of anesthesia was prepared to enhance dual processing of information and "bridge the gap between the textbook and the real patient" (Hartland et al., 2008, p. 197).

In choosing the target population for this intervention, Benner's novice to expert theory was employed (Benner, 1982). Using this theory, the progression of a learner is outlined into five different categories: novice, advanced beginner, competent, proficient, and expert (Marble, 2009). Students often start out as novices and as they grow in knowledge and experience advance into each category. A novice is a beginner who has no previous experience to draw conclusions from, and therefore, must rely on a set of rules to dictate practice (Marble, 2009). Due to their lack of experience, novice NATs were chosen as the target population who could most benefit from video simulation learning.

Literature Review

A literature review was conducted utilizing the following databases: CINAHL, PubMed, and ProQuest Nursing and Allied Health. The search strategy was focused on key concepts including "video recording", "video simulation", "learning in nurse anesthesia students", "sequence of induction of anesthesia", "rapid sequence induction (RSI)", and "video-based learning to increase knowledge". Due to a lack of evidence on video simulation as an educational strategy for nurse anesthesia students, the search was expanded to include the effectiveness of video learning strategies for healthcare professionals. No research was found in the literature search on video instruction for the sequence of induction of anesthesia; therefore, research pertaining to video-based learning in a wide array of clinical-based skills was examined to closely resemble the topic. Data relevant to the study included eleven research studies, as shown in Table 1. The research consisted of both qualitative and quantitative methods to examine various video-learning strategies to increase student clinical knowledge.

Video Simulation in Education

One of the objectives of nurse educators is to facilitate the transfer of a students' classroom knowledge to clinical practice (Sharpnack, Goliat, Baker, Rogers, & Shockey, 2013). The use of video scenarios as a teaching strategy has demonstrated its effectiveness in fostering a students' ability to associate acquired knowledge with previous experiences (Sharpnack et al., 2013). A pre test and post test quasi-experimental design study was conducted to examine the effectiveness of videotaped scenario simulations on critical thinking, quality, and safety competence in nursing students (Sharpnack et al., 2013). The Creighton Simulation Evaluation Instrument (C-SEI) was used to evaluate critical thinking skills and simulation performance of students and revealed a significant increase in all measured competencies between pre test and post test scores (Sharpnack et al., 2013). Student reflections following the study disclosed that videotaped scenarios, supplemented with classroom discussion, were helpful in applying knowledge from the classroom to clinical situations (Sharpnack et al., 2013). This article provides evidence to support the use of technology to bring classroom knowledge to the clinical setting, which is the objective of the video simulation intervention in this study.

Lee et al. (2016) found that the design and implementation of a mobile-based learning video clip for use in nursing education can enhance student motivation. A randomized controlled trial demonstrated that a mobile device could be used with video clips in nursing education to promote nursing students' learning, motivation, and confidence in acquiring a clinical skill (Lee et al., 2016). Results from the study revealed significant correlations among students' motivation level, confidence in practice, and satisfaction with the intervention (Lee et al., 2016). "The greatest benefit of using a mobile device was the accessibility and availability without the constraints of place and time" (Lee et al., 2016, p 15). Students in the study reported an additional benefit of the video clip in promoting fundamental nursing learning by providing opportunities for preview and review (Lee et al., 2016). Lee and colleagues further support the notion that video based learning can help students acquire a clinical skill, similar to learning the sequence of anesthesia.

A single-blinded, randomized controlled trial performed by Saiboon et al. (2014) revealed no statistical difference in the effectiveness of teaching basic airway management, cervical collar application, manual cardiac defibrillation, and emergency extremity splinting between self-instruction video (SIV) and face-to-face (FTF) instruction. The study found that when teaching videos are properly constructed and presented, they could have similar psychomotor learning outcomes as compared to outcomes developed from traditional FTF teaching (Saiboon et al., 2014). The inclusion of a 'close-up shot' or 'insert' in the video was noted to help improve student understanding and confidence while viewing the video (Saiboon et al., 2014). Student feedback revealed that confidence in performing a particular skill was enhanced using SIV because they were able to repeatedly watch and review the skills being taught (Saiboon et al., 2014). With there being no difference in outcomes between video learning and FTF instruction, this article explores the possibility of video simulation playing a larger role in curriculums in the future.

Woodworth, Chen, and Horn (2014) conducted a prospective, randomized study to determine the effectiveness of a short educational video and simulation on improvement of ultrasound image acquisition and interpretation skills in anesthesia residents. The primary outcome assessed was knowledge of anatomy and ultrasound interpretation skills, and was evaluated with a written test created by the authors. The written test was validated in a pilot study comprised of 42 anesthesia faculty members (Woodworth et al., 2014). This study offered preliminary data on the validity of a written knowledge test as potential assessment tool to evaluate ultrasound image interpretation and acquisition of skills in anesthesia residents (Woodworth et al., 2014). The research concluded that a short educational video on anatomy, key anatomic relationships, and ultrasound imagery presented along with a computer-based interactive simulation significantly improved performance on a written knowledge test, but failed to improve hands-on performance of ultrasound scanning to localize the nerve (Woodworth et al., 2014). Woodworth and colleagues evaluated knowledge through a self-developed assessment test after implementing a technology-based simulation. Knowledge was also evaluated in this study through an investigator-developed Knowledge Assessment Tool (KAT).

Effectiveness of video-based learning has been examined in a variety of professions. Chi, Pickrell, and Riedy (2014) conducted a retrospective cohort study with a historical control group to evaluate learning outcomes associated with technology-driven approaches versus traditional approaches in teaching public health to dental students. Students were assigned case reports to review and were split into two groups. The experimental group had the case reports accessible to them in a video presentation while the control group received the case reports in a tradition paper format. Results of one-way ANOVA test demonstrated that the students who received the video case reports showed significantly higher scores, leading them to better cognitive, affective, and overall learning outcomes (Chi et al., 2014). A variety of student populations were examined in this literature review to determine if video simulation was effective in many areas of education.

Comparing video-based learning to traditional methods has expanded into the area of nurse anesthesia education. McLain, Biddle, and Cotter (2012) used a randomized control crossover trial to investigate the effect of different teaching methods on recall and performance of student registered nurse anesthetists when exposed to crisis simulations. Students either received written case studies of situations involving compromised patient safety or audiovisual vignettes showing crisis situations (McLain et al., 2012). In comparing the two groups, McLain et al. (2012) found that the students who received video-based education had greater improvements in clinical performance compared to the group who received traditional learning methods. "Significant results in clinical performance measures may demonstrate higher cognitive processes, rather than simple memorization, and may indicate that information synthesis has occurred" (McLain et al., 2012, p. 15). In the nurse anesthesia trainee population, video simulation helped students to process and store information better than with traditional learning methods. This aim of this study is to replicate this result in teaching the sequence of anesthesia induction.

Student Perceptions of Video Simulation

Several studies have demonstrated the effectiveness of video simulation education on student outcomes; however, the value of the results is limited if students do not perceive video simulation to be effective. It is important that students recognize the usefulness of video simulation education. Chan (2010) surveyed students' beliefs and preferences for video instruction in learning. The survey results showed that students used instructional videos in a variety of ways: to understand concepts and theories, to view step-by-step demonstrations in performing a technical skill, and to familiarize themselves to unknown environments through simulations and virtual tours (Chan, 2010). The author also discovered that students referred to video instructions before accessing any other type of online instruction.

Kelly, Lyng, McGrath, and Cannon (2009) examined students' perception of online video learning while simultaneously assessing outcomes of knowledge and performance after utilizing video-based education in a randomized control trial and quasi-experimental design. The researchers found no statistically significant difference in skill performance between the students who received online instructional videos compared to face-to-face demonstration. However, female students were more inclined to learn skills through video than male students (Kelly et al., 2009). Authors concluded that instructional videos are as effective as face-to-face demonstration in teaching a psychomotor skill. Results of a questionnaire showed that students perceived video learning as a useful adjunct to lecture demonstrations (Kelly et al., 2009). This study supports the idea that students have a positive perception on video-based learning.

Teaching the Sequence of Anesthesia Induction

The sequence of anesthesia induction can be difficult skill for novice NATs to grasp initially. Several studies have evaluated the best way to teach this skill to students. Szlachta (2011) examined the learning outcomes of first year nurse anesthesia students who received faculty instruction in the high-fidelity patient simulator compared to those that received peer instruction using a post test only true experimental design (Szlachta, 2011). The skill that the nurse anesthesia students were evaluated on was the sequence of induction. The students' performances were evaluated using Morgan, Cleave-Hogg, Guest, & Herold's (2001) RSI Skill Checklist. The findings showed no statistically significant difference in learning outcomes between the faculty instruction group and the peer instruction group (Szlachta, 2011). A survey was sent out to participants after the study to evaluate the perceptions of the peer-instruction model. The feedback from the survey was mostly positive in relation to peer-instruction learning (Szlachta, 2011). This article gave two examples of how the sequence of induction can be taught to nurse anesthesia students. Video simulation can be another way to teach this skill and is explored in this study.

Educating anesthesia providers on the sequence of anesthesia induction is critical to ensuring safety in the patient population undergoing surgery. Endale, Kefale, Hintsawit, Keder, and Hulgize (2014) developed a hospital based observational study assessing performance of RSI and intubation technique. “The induction of general anesthesia in patients with risk of aspiration can result in regurgitation of gastric content and pulmonary aspiration. The role of RSI and intubation is to minimize the time interval between the loss of the airway protection reflexes and intubation with an endotracheal tube” (Endale et al., 2014, p.110). The results of the study concluded that correct performances of RSI and intubation were low in this university teaching hospital. Endale et al. (2014) identified a need for anesthetists to be properly trained in the sequence of rapid induction. The application of video-based learning to educate anesthesia providers is an approach that can be explored to help combat this problem.

Limitations of currently available research included small sample size. Many studies only utilized a particular population to participate in their research. Small sample size and non-randomized participants restrict the ability to generalize results of a study to the population at large. The amount of research exploring the use of video simulation education in the practice of anesthesia was also limited. Due to the sampling methods of several of the studies, results shown in one population may not be transferrable to another. This creates a need for more research assessing video-based education in anesthesia providers. Another limitation of the body of research relating to video simulation education lies in the study designs. There are very few randomized controlled trials in this body of literature. A result of this lack of research is the potential for existing studies to have problems with their internal validity and reliability.

In conclusion, the literature reviewed supports the use of video simulation education as an additional resource to enhance student learning. The use of instructional videos has been explored in several different populations, all with positive results as seen in Table 1. Student perceptions of video learning prove it is recognized as a valuable tool to enhance knowledge. Specific to the practice of anesthesia, video-based education is growing into an important part of the learning process. Students who want to master a clinical skill, like the sequence of induction, could benefit from the utilization of instructional videos to supplement the learning process.

Methods

Design

A single group pre test-post test design was used to evaluate the effectiveness of video simulation on enhancing knowledge and perceived knowledge in novice NATs at NorthShore University HealthSystem (NSUHS) School of Nurse Anesthesia (SNA) located in Evanston, Illinois. The project consisted of four phases: (1) development of a simulation video, (2) development of a KAT, (3) evaluation of video simulation on knowledge enhancement through use of the newly developed KAT (pre test 1 and post test 1), and (4) evaluation of video simulation on NAT's perceived knowledge utilizing a modification of the Okere, Renier, and Morse's (2014) Perceived Knowledge Survey (PKS) at pre test 2 and post test 2. To allow student participants an equal opportunity to view the simulation video as an adjunct to learning, separation of the participants into control and intervention groups was not performed.

Sample

A convenience sample of second year NATs at NSUHS SNA was utilized for the study. Only second year NATs enrolled in full-time graduate study with no previous clinical residency experience or simulation instruction were considered for inclusion. NATs attending NSUHS SNA possess a minimum of a Bachelor's of Science in Nursing degree and a minimum of two years of nursing experience in an intensive care unit setting. There was 18-second year NATs at NSUHS SNA at the time of this study. A convenience sample was chosen due to the small field of study and limited number of students meeting the inclusion criteria.

Recruitment Procedure

A detailed explanation of research objectives and an invitation to participate in the study from the researchers was forwarded to the email addresses of second year NATs by the Program Director Pamela Schwartz, DNP, CRNA. The investigators attached a recruitment letter to the email (Appendix E) as well as an information sheet (Appendix F) outlining the rights of the participants. Participation in the study was voluntary and no formal consent was required. No monetary or other incentives were offered. All data collected was kept anonymous and the KAT score did not count towards any course work. The data collection took place on Saturday October 8, 2016 and was held in a conference room at NSUHS, Evanston Hospital. Nurse anesthesia trainees who wished to volunteer were already at the hospital, and therefore no added travel was required. All volunteers were briefed on the research objectives by the investigators prior to administering the KAT and PKS. Subject participation of pre tests and post tests was considered implied consent.

Pre-Recorded Video of Simulated Anesthesia Induction

The intervention utilized in this study is a video of simulated anesthesia induction using standard and rapid sequences. Prior to filming the instructional video, the investigators reviewed the literature to develop evidence-based steps in performing the standard induction of general anesthesia and RSI. “Although there is no one accepted standard performance tool to evaluate the induction and intubation of a patient, there are tasks common to all anesthesia inductions” (Chiffer-McKay, Buen, Bohan, & Maye, 2010, p. 304). Due to the lack of valid and reliable evaluation tools for student performance of intubation and anesthesia induction, Chiffer-Mckay et al. (2010) developed an objective checklist for standard induction and intubation criteria. The contents of the this checklist was combined with educational materials from NSUHS SNA to create a seamless educational piece for the students in regard to standard induction as seen in Appendix A.

The steps for the RSI were created by also combining educational material from NSUHS SNA and items found in the literature. In assessing student learning in the high fidelity patient simulator, Szlachta (2011) utilized Morgan et al.’s (2001) RSI Skill Checklist. The investigators streamlined these steps with existing checklists from NSUHS SNA to create an outline for the video simulation as seen in Appendix A. This outline was submitted for review and revision for content validity by a five member expert panel consisting of NSUHS SNA Program Director, Pamela Schwartz DNP, CRNA and faculty instructors, Julia Feczko DNP, CRNA, Karen Kapanke DNP, CRNA, Susan Krawczyk DNP, CRNA, and Bernadette Roche EdD, CRNA. Each component of the outline was assessed for clarity, relevance, simplicity, and consistency and scored on a scale of 1-10, with 1 being the lowest score and 10 being the highest. In order to be approved for content validity, each component of the outline of the instructional video had to obtain a score of 10 in each of the four categories by each member of the expert panel. After several revisions, the outline of the video was approved for 100% content validity. The investigators were then able to proceed with filming of the video.

A simulation of a standard induction sequence of general anesthesia and a RSI was video recorded in the Grainger Center for Simulation and Innovation (GCSI) located within NSUHS (NSUHS, 2017), Evanston Hospital and compiled in one video. The content of the video consisted of the approved checklists for standard and RSI of anesthesia. Committee member, Karen Kapanke DNP, CRNA was present for the filming of the video to offer assistance and to ensure the investigators followed the approved outline for the video. The beginning of the video stated the purpose along with an introduction of the skills to be demonstrated. Then, a step-by-step instructional demonstration of each type of anesthesia induction was performed. Close-up shots were utilized when needed. The focus of the video was on the flow of induction rather than the technical skills needed to perform each step in the process.

Instruments

The two major outcomes assessed were knowledge and perceived knowledge. These two outcomes have been considered as important and relevant outcomes in video education based on the literature review conducted for this current study.

Knowledge Assessment Tool

In this study, knowledge level on anesthesia induction was assessed using KAT standard induction and KAT RSI at pre test and post test measurements. The mean scores from pre and post tests were examined for statistically significant differences after viewing the educational video simulation described in Appendix C. The KAT was developed by the investigators to measure knowledge on the correct sequence of anesthesia induction specifically used in the pre-recorded video simulation. The KAT had two sections: first section evaluated the knowledge of a standard anesthesia induction sequence (13 steps) and the second section evaluated knowledge of a RSI of anesthesia (11 steps).

The contents of KAT were reviewed by a five member expert panel, consisting of NSUHS SNA Program Director, Pamela Schwartz DNP, CRNA and faculty instructors, Julia Feczko DNP, CRNA, Karen Kapanke DNP, CRNA, Susan Krawczyk DNP, CRNA, and Bernadette Roche EdD, CRNA. Each question was assessed for clarity, relevance, simplicity, and consistency and scored on a scale of 1-10, with 1 being the lowest score and 10 being the highest. After several revisions, each question on the KAT had a score of 10 in each of the four categories by each member of the expert panel, establishing the content validity of the KAT.

Perceived Knowledge Survey

An adapted version of the five-item PKS originally developed by Okere, Renier, and Morse (2014) was used to measure perceived knowledge in this current study. The PKS has been found to be a valid and reliable instrument for evaluating perceived knowledge with a reported Cronbach's alpha value of .74 (Okere et al., 2014). Permission to use the survey was granted by the primary author Arinze Okere. Survey questions were modified slightly to fit the context and the subject matter of this current study.

Human Subjects Protection

Prior to completing the applications for the Institutional Review Boards (IRB) of NSUHS, the investigators completed the Collaborative Institutional Training Initiative (CITI) and Financial Conflict of Interest (FCOI) training. This training ensured the investigators were educated in conducting research that protected their human subjects. The IRB applications included all aspects of the project as well as a committee member agreement of the proposed project. The IRB application also explained that subject participation in the study is voluntary and all data obtained will be kept confidential. The recruitment plan was outlined including the information sheet as seen in Appendix F that contained an explanation on the purpose of the study, protection of privacy, right to cessation of the study without penalty, and the investigators contact information for questions prior to participating in the study.

In order to protect the privacy of the study participants, the demographic survey was a separate form and collected in a manila envelope, labeled demographic surveys, prior to distributing the other surveys. The pre test and post test surveys were collected by each participant in a separate manila envelope labeled pre test post test. Using this method, demographic information from the participants were not linked to data collected from the pre and post surveys. All data obtained from the study was kept securely in separate manila envelopes and stored in a locked cabinet.

Prior to the start of the study, the researchers stated the voluntary nature of the study, including surveys and video viewing. An explanation of the voluntary nature of the study is explicitly stated at the top of each survey along with instructions for completion (see Appendices B, C, D). Participants were informed that there was no formal signed consent and that the submission of the surveys was considered to be implied consent. There was no monetary or other provided incentive for NATs to participate in this study. By voluntarily completing the surveys involved in the study, the NAT implied consent to participate. Distribution of paper surveys and watching of the video-based simulation occurred during the participant's normal didactic schedule. All content provided to them was relevant to their area of study.

Data Collection Procedure

After approval by the DePaul University and NSUHS IRBs, data collection was held on October 8, 2016 in a conference room at NSUHS, Evanston Hospital. A convenience sample of volunteer NATs participated in the study. Participation in the study, including completion of pre test-post tests and viewing of the video, took approximately 40 minutes. Students were informed that participation was voluntary, anonymous, and can be terminated at any time. All data obtained from volunteers remained confidential and were stored in locked cabinets and on password protected devices owned by the researchers.

A short demographic survey (gender, age, ethnicity, education level and intensive care unit experience) was included along with the KAT (pre test 1) and PKS (pre test 2). Once completed, the participants were shown the video on the sequence of induction, including standard induction and RSI. After viewing the video, the participants retook the KAT (post test 1) and the PKS (post test 2). The post test and pre test results were compared to determine if there were significant changes in knowledge and perceived knowledge after viewing the educational video simulation.

Data Analysis

Each data set for PKS and KAT (standard induction and RSI) at pre and post test was examined for appropriate use of parametric statistics. According to Doane & Seward (2011), the acceptable range of skewness for data set with a sample size of 12 is approximately +0.9 to -0.9. After exploring all data sets, only the KAT RSI data set falls within this range, meeting the normality of data distribution requirement for parametric testing. Given that the KAT RSI data set met all the assumptions of parametric testing, a paired samples *t* test was used for analysis of this particular data set. The nonparametric Wilcoxon Signed Ranks test was used to analyze all three data sets on PKS and KAT standard induction and PKS RSI. A *p* value equal or < 0.05 was considered statistically significant. The Cohen's *d* statistics accompanied the paired *t* tests and the Wilcoxon tests to describe the effect size of video education on KAT and PKS standard induction and RSI mean scores. The reliability of the instruments used in this study was established using KR-20 test for KAT (KAT standard and RSI had KR-20 = 0.5 or higher) and the Cronbach's alpha coefficient test for PKS standard and RSI had Cronbach's alpha = 0.7 or higher. All data analyses were performed using International Business Machines (IBM) SPSS version 24 (IBM, 2017).

Results

Twelve NATs participated in this study. Of the 12 participants, only nine revealed gender information. Five participants identified themselves as female and four as male. All 12 participants provided information on their age range. Fifty percent of the NAT participants were above the age of thirty; three were ages 31-35, and two were 36 or greater. Caucasian was the predominant ethnicity of study participants (75%; n=9). Seventy five percent (n=9) of participants hold a Bachelor's of Science in Nursing degree and 25% (n=3) hold a Master of Science in Nursing degree. The majority (83.3%) of participants had 3-5 years of ICU experience prior to nurse anesthesia school. Only 8.3% had less than 2 years of ICU experience and 8.3% had 6-9 years of ICU experience prior to starting the program. Socio-demographic data results are summarized in Table 2.

Perceived Knowledge Standard Induction of Anesthesia

The PKS standard induction instrument is comprised of 5 survey questions, with each item scored on a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5) (see Appendix D). The mean scores for pre and post tests were the average of all the values in the

PKS standard induction data set. The mean scores for individual items on PKS standard induction prior to video simulation (pre test survey) ranged from 2.166 to 3.416. The item on naming all of the steps in the sequence in the correct order had the lowest mean score of 2.1667 (*SD* = 0.937) and 4.0 (*SD* = 0.603) at pre and post test, respectively as seen in Table 3. The item on perceived ability to name all the steps in a standard induction sequence had the greatest improvement in mean scores from 2.25 (*SD* = 0.866) to 4.5 (*SD* = 0.522) at pre and post test, respectively.

The Wilcoxon signed ranks test showed a statistically significant difference between pre- and post test mean scores on PKS standard induction. The mean scores between pre- and post tests for each ordinal outcomes on the PKS standard induction were all statistically significant as seen on Tables 4 and 5 (all *p values* = or <0.05). The video simulation education is effective on improving the perceived knowledge on all five items in the PKS. The Cohen's *d* for effect size measures the extent of the presence of a phenomenon (e.g., video simulation) in a population (Burns & Grove, 2009). In this study, using the paired samples *t* test data (*M* = -7.83; *SD* = 2.69), the computed Cohen's *d* = -2.91. A Cohen's *d* value above 0.8 is considered a large effect size that can be attributed to the intervention. A negative Cohen's *d* value underscores a positive effect of video simulation on perceived knowledge for a standard induction of anesthesia.

Perceived Knowledge RSI of Anesthesia

The PKS for RSI also consisted of 5 survey questions with each question scored on a 5-point Likert scale. Analysis of PKS RSI data set revealed pre test mean scores ranging from 2.75 to 3.83 as shown in Table 6. Similar to PKS standard induction, the item on naming all the steps in the RSI of anesthesia in the correct order had the lowest mean score (*M* = 2.75; *SD* = 1.215) among the five items. The item on when to perform RSI of anesthesia had the highest mean score

(*M* = 3.83; *SD* = 0.717) among the five items. This is a similar finding on the item with the highest pre test mean score on PKS standard induction. Overall, there are statistically significant differences in perceived knowledge in all five ordinal outcomes on PKS RSI (all *p* values were = or < 0.5) as shown in Table 8. Using the data from paired samples *t* test (*M* = -5.00; *SD* = 3.133), the computed Cohen's *d* value = -1.6, indicating that the intervention had a large effect size on PKS RSI pre and post test mean scores. A negative Cohen's *d* value underscores a positive effect of video simulation on perceived knowledge RSI.

Knowledge on Standard Induction Sequence of Anesthesia

The knowledge level of participants was measured using the investigator-developed KAT standard induction instrument, which consisted of 13 steps that the study participants were asked to sequence correctly. Each step was worth one point with a potential score range of 0-13. The mean score for the pre test group (n = 12) was 6.167 and the post test group (n = 12) was 9.583 as shown in Table 9. The KAT standard induction data set revealed skewness value of 1.383, which is beyond the range of 0.9 and -0.9 for normally distributed data in a study with a sample size of 12 (Doane & Seward, 2011). Given this information, the Wilcoxon signed ranks test was used to determine statistically significant difference between the pre and post mean scores on KAT standard induction.

A detailed description of KAT standard induction with all the 13 items and their corresponding frequencies for correctly sequenced items can be seen in Table 10. The participants scored lowest on the sixth step, "attempt to mask ventilate", with only two students (16.7%) answering correctly prior to viewing the video simulation. After watching the video simulation, 50% correctly sequenced the sixth step. The majority of participants (91.7%) correctly identified the first step, "apply standard monitors, assess baseline vitals, and confirm presence of free flowing intravenous fluid" at pre test. All the participants correctly identified the first step during post test. The greatest improvement in correct sequencing for KAT standard induction can be seen on step number 10, "inflate endotracheal tube cuff, connect circuit, and manually ventilate" (25% to 75%, during pre and post tests, respectively). Overall, there is a statistically significant increase in the mean scores on KAT standard induction of anesthesia ($Z = -2.944$; $p = 0.003$) as shown in Table 11. Using the data from paired samples *t* test ($M = -3.417$; $SD = 2.391$), the computed Cohen's *d* value was -1.429, indicating a large effect size that can be attributed to the video simulation.

Knowledge on RSI of Anesthesia

The knowledge level of participants on RSI was measured using KAT RSI. The mean scores for KAT RSI were computed using the 11 steps that the participants were asked to sequence correctly. Each step was worth one point with a potential score range of 0-11 for pre and post test. The mean score for the pre test group (n = 12) was 4.083 and the post test group (n = 12) was 8.667 as shown in Table 12.

A detailed description of the 11 items on KAT RSI with corresponding frequencies for correctly sequenced steps can be seen in Table 13. All participants scored higher in all 11 items during the post test when compared to the pre test. During pre test, steps two, eight, and ten had the lowest scores with only three students sequencing each of these steps correctly. Step six, "administer intravenous induction and muscle relaxant medications" was sequenced correctly by a majority of participants (n=7; 58.3%) during pre test. The greatest change from pre test to post test was observed in step two, "apply standard monitors, assess baseline vitals, and confirm presence of free flowing intravenous fluid" where only three students (25%) sequenced this step correctly during pre test and 11 students (91.7%) sequenced it correctly during post test.

The KAT RSI data set met all the assumptions of parametric testing, hence a paired samples *t* test was used to examine statistically significant difference in the mean scores on KAT RSI between pre and post tests. There is a significant difference between pre and post test mean scores on KAT RSI ($t = 4.711$; $p = 0.001$) as seen on Table 14. Using paired samples *t* test data, the computed Cohen's $d = -1.360$, underscoring a large positive effect size that can be attributed to video simulation.

Discussion

Previous research has shown the effectiveness of video simulation as an educational strategy. However, there was a lack of anesthesia-related research in regards to this topic. This study explored the use of video simulation in the education of nurse anesthesia trainees and contributed to the scarce body of evidence available in this population. The sequence of anesthesia induction is a difficult concept to grasp for a novice nurse anesthesia trainee. The investigators were not aware of any research conducted previously on video simulation education on the sequence of anesthesia induction. The induction of anesthesia is a critical skill for novice nurse anesthesia trainees to learn before they start their clinical rotations. The flow of anesthesia induction is typically taught in the classroom and simulation lab at NSUHS SNA. The video simulation shown in the study offered an alternative method for the novice NAT to understand this important skill.

Induction of anesthesia is typically performed either as a standard induction or as a RSI. RSI is indicated when a patient is at risk for aspiration of gastric contents (Endale et al., 2014). The sequence of each type of induction varies and it was important to test these two concepts separately. The steps for each type of induction are outlined in Appendix C. Standard and RSI surveys showed similar increases in affecting knowledge and perceived knowledge after the video simulation.

The research evaluated novice NATs' knowledge and perceived knowledge on the sequence of anesthesia induction before and after viewing a video simulation. The following questions were proposed prior to conducting the study:

- Does viewing a video simulation of the induction sequence of anesthesia increase knowledge in novice NATs?
- Do novice NATs report a greater perception of knowledge after viewing a video simulation?

The results of this study adequately answered both of these questions. Knowledge on the sequence of induction was shown to have a statistically significant increase from the pre test KAT to the post test KAT using the Wilcoxon signed ranks test for standard induction and the paired samples *t* test for RSI. Nurse anesthesia trainees reported higher scores of perceived knowledge on the post test PKS compared to the pre test. Results of the Wilcoxon signed ranks test analyzing the PKS were also statistically significant. The video simulation increased both knowledge and perceived knowledge of the sequence of anesthesia induction in the novice NAT population. Due to the positive impact of the video, it can be inferred that this video simulation can enhance knowledge to a greater extent compared to traditional teaching strategies alone.

The target population of this pilot study was second year nurse anesthesia trainees at NSUHS SNA prior to the start of their clinical rotations. Participants in the study included 12 NATs. The majority of the participants were female, Caucasian, between the ages of 26-30, held a Bachelor's of Science in Nursing Degree, and had 3-5 years Intensive Care Unit experience prior to beginning the nurse anesthesia program. Due to the Demographic Survey being collected separately from the PKS and KAT, it was not possible to determine if specific demographic characteristics had an effect on the results of the surveys. Since all participants had some base of clinical knowledge before implementation of this study, it can be inferred that results would be different if this study tested a student population with no exposure to the concepts explored in the video simulation. Alternatively, if this study was implemented after the NATs were exposed to the sequence of induction in the clinical setting or simulation lab, the results of the pre test would most likely be higher yielding less of a difference between pre test and post test mean scores.

It was initially assumed that parametric testing would be used and paired samples *t* tests would analyze the data. The KAT for RSI followed these assumptions and a paired samples *t* test was suitable to analyze this data. This was not the case for the PKS for both standard and RSI and the KAT for standard induction. The KAT standard did not have data that was normally distributed and therefore did not meet the assumptions for the paired samples *t* test. Even though the PKS had a normally distributed histogram, it did not meet the criteria for homogeneity of variance. The PKS was also a Likert scale survey with ordinal data, which typically qualifies for nonparametric testing (Knapp, 2017). Therefore, the nonparametric Wilcoxon signed ranks test was appropriate for data analysis of these surveys. Non-parametric testing is used when the assumptions of parametric procedures are not met. According to Burns & Grove (2009), the most frequently violated assumption is that data is obtained from a random sample. The participants of this pilot study were not selected from a random sample; instead, they were selected from a very specific target population. This could have been a reason for not meeting the assumptions of the paired *t* test. When parametric assumptions are met, non-parametric tests have a greater risk for type II error (Burns & Grove, 2009). Even though some assumptions of parametric testing were met, the effect of type II error on the results is minimal because the null hypothesis was rejected in this pilot study.

The statistically significant results of this study prove that implementation of the video simulation had a positive effect on knowledge and perceived knowledge in the novice nurse anesthesia trainee population. This claim is strengthened by the proven reliability of both surveys used to assess knowledge and perceived knowledge along with the p values <0.05. There were also several consistencies in the scoring of the surveys between standard and RSI. For instance, the question with the lowest score was the same in both PKS standard and RSI. The effectiveness of video simulation in education has current implications for practice. The role of technology is expanding in education and this pilot study supports the use of video simulation in the nurse anesthesia trainee population.

Ethical Consideration

The Institutional Review Boards of NSUHS and DePaul University approved this study for implementation. Students were recruited to participate by an email and an attached information sheet explaining the purpose of the study, protection of privacy, right to cessation of the study without penalty, and the investigators contact information for questions prior to participating in the study.

In order to protect the privacy of the study participants, the demographic survey was a separate form and collected in a manila envelope labeled demographic surveys prior to distributing the other surveys. The pre test and post test surveys were collected by each participant in a separate manila envelope labeled “pre test” and “post test”. Therefore, demographic information from the participants was not linked to data collected from the pre and post surveys. All data obtained from the study was kept securely in separate manila envelopes and stored in a locked cabinet.

Limitations

A limitation of this study was the small sample size of twelve students. Because the target population was second year nurse anesthesia trainees at NSUHS SNA, this restricted the amount of participants that could volunteer. The nonrandom convenience sample used in this study could also have led to selection bias. Another limitation relating to the target population was the lack of diversity of participants. However, the demographic information was a reflection of the target population as a whole. Even though this pilot study had a small sample size and lack of diverse participants, the strength of the statistically significant findings allow the results to be generalized to a larger nurse anesthesia trainee population.

Since this study did not link demographic information to the surveys, it was limited in interpreting the results to a particular student population. Future research associating demographic information, like gender or age, with knowledge and perceived knowledge of video simulation could provide insight to educators and help tailor learning needs to the individual student.

Future Recommendations

In order to strengthen the results of this study even further, research needs to be completed to test this intervention with a larger sample size. This research was intended to be a pilot study because the authors were not aware of any other study of its kind to test knowledge of the sequence of anesthesia induction after implementation of a video simulation. The positive findings of this research can be reinforced if the results are replicated by a study with a higher level of evidence, like a randomized control trial. It would also be beneficial to study potential associations of demographic groups with KAT and PKS scores to understand if there are differences in the learning process of various groups in relation to video simulation education.

As mentioned previously, the literature showed positive results for video simulation as an educational strategy, but there was a lack of research relating to anesthesia. This study served to decrease that gap in the body of evidence by testing the effects of a video simulation in the nurse anesthesia trainee population. More research is needed to supplement this study as well as contribute to video simulation education on other areas of anesthesia. Video simulation can play an important role in teaching several other skills to nurse anesthesia students.

Finally, due to the positive results of this video simulation on the sequence of induction, it is recommended by the authors to incorporate this video into the anesthesia curriculum at NSUHS SNA to benefit those students who did not participate in the study and future nurse anesthesia trainees. Many of the articles in the literature review mentioned that video simulation education was effective for students because it allowed this population easy access to repeatedly review certain skills or concepts. Having this video simulation available on the NSUHS SNA website will allow it to serve as a reference tool to the nurse anesthesia trainees. Research to evaluate the effects of this video on clinical performance is a potential future area of exploration.

Conclusion

The use of technology can supplement traditional learning methods. The findings of this study demonstrate that viewing a video simulation on the sequence of anesthesia induction increased knowledge and perceived knowledge in novice NATs. The results of this anesthesia-specific study were consistent with the body of literature showing the positive effects of video simulation in education. The strong results of this pilot study lead to the conclusion that there is a role for video simulation in the curriculum of nurse anesthesia programs and more research is needed to explore this educational strategy.

References

Benner, P. (1982). From novice to expert. *American Journal of Nursing, 82*(3), 402-407.

Burns, N. & Grove, S.K. (2009). Chapter 14: Sampling. *The practice of nursing research: Appraisal, synthesis, and generation of evidence*. St. Louis, MO: Saunders Elsevier, Inc.

Chan, M.C. (2010). Video instructions as support for beyond classroom learning. *Procedia Social and Behavioral Sciences, 9*(2010), 1313-1318. doi: 10.1016/j.sbspro.201012.326

Chi, D. L., Pickrell, J. E., & Riedy, C. A. (2014). Student learning outcomes associated with video vs. paper cases in a public health dentistry course. *Journal of Dental Education*, *78*(1), 24-30.

Chiffer-McKay, K.A., Buen, J.E., Bohan, K.J., & Maye, J.P. (2010). Determining the relationship of acute stress, anxiety, and salivary α-amylase level with performance of student nurse anesthetists during human-based anesthesia simulator training. *American Association of Nurse Anesthetists Journal*, *78*(4), 301-309.

Clark, J. M., & Paivio, A. (1991). Dual coding theory and education. *Educational Psychology Review, 3*(3), 149-210.

Doane, D. P. & Seward, L.E. (2011). Measuring skewness: A forgotten statistic? *Journal of Statistics Education, 19*(2), 1-18.

Endale, G.G., Kefale, D.G., Hintsawit, A.A., Keder, E.O., & Hulgize, N.A. (2014). Techniques of rapid sequence induction and intubation at a university teaching hospital. *World Journal of Emergency Medicine, 5*(2), 107-111. doi:10.5847/wjem.j.issn.1920-8642.2014.02.005

Hartland, W., Biddle, C., & Fallacaro, M. (2008). Audiovisual facilitation of clinical knowledge:

A paradigm for dispersed student education based on Paivio's Dual Coding Theory. *American Association of Nurse Anesthetists Journal*, *76*(3), 194-198.

International Business Machines. (2017). *IBM SPSS statistics.* Retrieved from http://www.ibm.com/analytics/us/en/technology/spss/

Kelly, M., Lyng, C., McGrath, M., & Cannon, G. (2009). A multi-method study to determine the effectiveness of, and attributes to, online instructional videos for teaching clinical nursing skills. *Nurse Education Today, 29*(3), 292-300. doi:http://dx.doi.org.ezproxy.depaul.edu/10.1016/j.nedt.2008.09.004

Knapp, H. (2017). Chapter 9: Paired *t* Test and Wilcoxon Test. *Practical statistics for nursing using SPSS*. Thousand Oaks, CA: Sage Publications, Inc.

Lee, N.J., Chae, S.M., Kim, H., Lee, J.H., Min, H.J., & Park, D.E. (2016). Mobile-based video learning outcomes in clinical nursing skill education: A randomized controlled trial. *Computers, Informatics, Nursing, 34*(1), 8-16.

Marble, S. (2009). Five-step model of professional excellence. *Clinical Journal of Oncology Nursing*, *13*(3), 310-315. doi:10.1188/09.CJON.310-31

McLain, N.E., Biddle, C., & Cotter, J.J. (2012). Anesthesia clinical performance outcomes: Does teaching method make a difference? *American Association of Nurse Anesthetists Journal, 80*(4), S11-S16.

Morgan, P.J., Cleave-Hogg, D.M., Guest, C.B., & Herold, J. (2001). Validity and reliability of undergraduate performance assessments in an anesthesia simulator. *Canadian Journal of Anaesthesia*, *48*(3), 225-233.

NorthShore University HealthSystem. (2017). *Grainger Center for Simulation and Innovation.* Retrieved from http://www.northshore.org/center-for-simulation-and-innovation/

Okere, A.N., Renier, C. M., & Morse, J. (2014). Development and validation of a survey to assess patient-perceived medication knowledge and confidence in medication use. *Journal of Nursing Measurement*, *22*(1), 120-134. doi:10.1891/1061-3749.22.1.120

Saiboon, I.M., Jaafar, M.J., Ahmad, N.S., Ahmad-Nasarudin, N.M., Mohamad, N., Ahmad, M.R., & Gilbert, J., (2014). Emergency skills learning on video (ESLOV): A single-blinded randomized control trial of teaching common emergency skills using self-instruction video (SIV) versus traditional face-to-face (FTF) methods. *Medical Teacher, 36*(3), 245-250. doi:10.3109/0142159X.2013.857013

Sanders A.E., Lushington, K. (2002). Effect of perceived stress on student performance in dental school. *Journal of Dental Education, 66*(1), 75-81.

Sharpnack, P.A., Goliat, L., Baker, J.R., Rogers, K., & Shockey, P. (2013). Thinking like a nurse: Using video simulation to rehearse for professional practice. *Clinical Simulation in Nursing, 9*(12), e571-e577.

Szlachta, J. (2011). *The effect of a peer-instruction model on nurse anesthesia student learning in the high-fidelity patient simulator* (Order No. 3481823). Available from ProQuest Dissertations & Theses Global. (907539597). Retrieved from http://ezproxy.depaul.edu/login?url=http://search.proquest.com/docview/907539597?accountid=10477

Woodworth, G.E., Chen, E.M., & Horn, J.E. (2014). Efficacy of computer-based video simulation in ultrasound-guided regional anesthesia training. *Journal of Clinical Anesthesia, 26*(3), 212-221. doi:10.1016/j.jclinane.2013.10.013