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Title Page

Evaluating the Effectiveness of Video-Based Education of Venous Gas Embolism for Nurse Anesthesia Trainees

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Abstract

Background/Significance: Video-based learning is a growing method being utilized to train nurse anesthesia trainees (NATs) in crisis management, such as a venous gas embolism (VGE). Use of this educational modality may improve crisis management skills, competence, and confidence in the NAT.

Purpose: The purpose of this project was to evaluate the effectiveness of an educational video in enhancing the appropriate crisis management of VGE among NATs as measured by their knowledge and confidence levels.

Methods: A quasi-experimental pretest-posttest design on a single group of participants was utilized for this project. A total of 14 first year NATs were recruited from NorthShore University HealthSystems School of Nurse Anesthesia (NSUHS) and participated in this study. An instructional video that simulates the proper management of VGE, a knowledge assessment tool (KAT) to assess non-technical skills knowledge pertaining to VGE, and a student confidence survey were developed for implementation of this study.

Results: A Wilcoxon Signed Matched-Pairs Ranks Test demonstrated that the median post-test scores were statistically higher that the median pre-test scores between pre and post-instructional video [Z= -3.301; p=0.001 (2-tailed)]. The knowledge questionnaire had an adequate post-test Kuder-Richardson-20 (KR-20) coefficient value =0.678.

Conclusion: NATs that participated in the study gained knowledge and confidence from pre and post video implementation. The mean scores improved in every knowledge category (prevention, recognition, decision-making, and prioritization) and confidence category (identification, management, and learning crisis management).

Key Words: video-education, venous gas embolism, teaching-methods, crisis management, confidence levels, nurse anesthesia trainees, non-technical skills

1. Introduction

1.1 Background and Significance

      A Venous Gas Embolism (VGE) is defined as the entrance of gases such as air or carbon dioxide into venous circulation, which may ultimately travel to the right side of the heart (Gaba, Fish, Howard, & Burden,2015). VGEs develop when air or other gases enter the vasculature from an existing pressure gradient and are considered to be potentially fatal (Onder, 2017). Surgeries that present the highest risk for VGE development include neurosurgery, laparoscopic, orthopedic, obstetric-gynecological, and cervical laminectomies (Onder, 2017). Posterior fossa surgeries that are performed in the sitting position have the highest rates of VGE incidence (Onder, 2017).

      It is estimated that VGE occurrence rates range from 10% (in the prone position) to 80% (in patients undergoing cranial synostosis in the Fowler's position) during neurosurgical procedures (O'Dowd & Kelley, 2017). Sequelae of VGE development includes cardiac arrhythmias, systemic hypotension, decreased oxygen saturation, and ultimately cardiovascular collapse (Gaba et al., 2015). Mortality rates associated with VGE occurrence can be as high as 28% (Onder, 2017).

      Video-based education is a growing method being utilized to train nurse anesthesia trainees (NATs) in crisis management, such as a VGE. Video-based learning acts as a supplemental adjunct to traditional lectures, reading material, and clinical experiences. An important benefit to this learning method is that it allows students to improve their performance without the risk of causing patient harm. This project aims to assess the effectiveness of video-based learning to educate novice NATs on the management of VGEs.

1.2 Theoretical Framework

      According to Mayer's Cognitive Theory of Multimedia Learning (CTML), the brain interprets a multimedia representation of words, pictures, and auditory sounds in a dynamic fashion instead of exclusively to create mental constructs (Gadbury-Amyot, Purk, Williams, & Van Ness, 2014). Research has demonstrated that the combined use of visual and verbal cues to facilitate the acquisition of motor skills results in better retention, accuracy, and execution of the skill (Gadbury-Amyot et al., 2014). Under this theory, learners achieve higher rates of retention when audio and visual representations are used to engage the learner rather than text alone (Gadbury-Amyot et al., 2014). Mayer's CTML follows three assumptions (Saad, Dandashi, Aljaam, & Saleh, 2015):

- Auditory and visual channels are the main routes for processing information.

- Each channel has a fixed capacity for cognitive load.

- The learning process is active and involves the filtering, selecting, organizing, and integration of information.

A second theory that aligns with this project's theoretical framework is Paivio's Dual Coding Theory (DCT). As the current generation of NATs increasingly utilizes internet applications such as teleconferencing, online lectures, and electronic classrooms, this theory helps describe a new era of learning. The DCT hypothesizes that individuals possess two parallel, yet interconnected, sensory systems that work together to process their surroundings (Hartland, Biddle, & Fallacaro, 2008). The two sensory systems (one based on imagery and the other on language) act as brain-mediated cognitive processors that are interconnected and results in the "dual coding" of information (Hartland et al., 2008). The DCT suggests that information that is input is more likely to be retained and retrieved when dual coding occurs (Hartland et al., 2008); this is especially useful in the nurse anesthesia education which involves teaching students to perform complex interventions. According to the DCT, the utilization of visualization improves and enhances learning and recall (Hartland et al., 2008).

The CTML and DCT were chosen to describe the theoretical framework for this video-based simulation project on VGE management; the themes of both theories suggest that that audiovisual vignettes facilitate the education of psychomotor skills and amplify cognition compared to written/lecture presentations alone. The study researchers encourage NATs to actively participate in the use of video-based education, and hope to improve retention and recall rates, as well as student confidence levels.

2. Materials Studied

2.1 Search Method

A literature review was conducted using the following databases: CINAHL, PubMed, ProQuest Nursing and Allied Health, and ScienceDirect. The search was conducted utilizing the following keywords: "video simulation," "video education," "teaching methods," "crisis management," "simulated crisis management," "confidence levels," "educational technology," and "problem-based learning." The search was expanded to include evidence from other medical professions and was not limited to anesthesia-related learning techniques. The data was limited to recent peer-reviewed articles within the past ten years.

2.2 Education Technologies

The incorporation of technology, such as simulation learning, engages students to actively participate in knowledge construction to develop competencies in various contexts (Jin & Bridges, 2014). Today's learners have grown up in the digital era with the rapid technological advancements of the 21st century, and research continues to examine the role of emerging educational technologies as a part of problem-based learning (Jin & Bridges, 2014). This includes the use of video-simulation techniques.

2.3 Video-Simulation Techniques

Video simulation is defined as "using interactive videos to mimic the reality of a clinical environment or situation" (Sharpnack, Goliat, Baker, Rogers, & Shockey, 2013, p. 572). Video-simulation use has recently grown because of its ability to serve as a visual adjunct for student health care practitioners. Specifically, teaching clinical skills used in the workplace are captured in a clear, easy-to-understand way that learners can witness firsthand without the chance for misinterpretation from a traditional lecture or written presentation. Some of the advantages of video-simulation learning reported by learners include enhanced learning, increased interest, the promotion of self-learning, and a clear presentation by watching a demonstration (Bala et al., 2016). Additionally, certain skills such as clinical reasoning are difficult to teach in a classroom setting. Video education has been reported to improve comprehension of topics as well as improve learner satisfaction, ultimately leading to a more integrated understanding of the skill or material being taught (Bala et al., 2016).

Video-education is widely utilized to foster psychomotor skills while developing critical thinking and clinical judgment skills (Sharpnack et al., 2013). Nursing students have reported increased levels of satisfaction and produced higher exam scores when video-based education was incorporated into lessons (Sharpnack et al, 2013). By integrating audiovisual learning into the traditional lecture format, educational outcomes are improved. Recorded video simulations afford students an interactive opportunity to develop the management skills of patients in high-acuity settings. Watching a video also allows students to anticipate the associated potential complications and safety concerns, which ultimately helps guide clinical judgment and decision-making.

2.4 Students' Perceptions and Confidence of Video-based Education

Video-based education has the intention of teaching a skill to better prepare the learner to carry out the task independently, competently, and with confidence. For example, NATs prepare to enter the clinical operating room (OR) setting by using various learning modalities: traditional lecture, studying text, viewing video instruction, and practicing live simulation. For skills that require multiple steps and precision, video services are a useful way to

illustrate how a task can be completed accurately. Anecdotally, videos may help alleviate fears and anxiety that new clinicians have when faced with unfamiliar settings or tasks.

Students in a computer-based learning course provided feedback that revealed that videos have not only assisted in learning enhancement, but have also helped in student retention due to their superior ability in holding student's attention (Chan, 2010). Compared to other learning techniques, video instruction has been the preferred method of learning by students (Chan, 2010). Utilizing videos as an educational tool has increased student interest by creating a clearer picture in a simple way (Bala et al., 2016). Students felt they had a better understanding of the material when presented in a video format (Bala et al., 2016). Enhanced understanding will allow students to have elevated levels of confidence as they enter into the clinical arena.

A study by Lee et al. (2016) involving 71 nursing students revealed that the number of viewings of an educational video was positively correlated with confidence in practicing the skill being taught. Learners reported that they could feel their interest increasing when viewing videos because they integrate voice, image, and action simultaneously (Bala et al., 2016). Viewers were also given the ability to rewind and replay the video, which improves retention rates. Video-education provides the opportunity to observe a demonstration of a skill, and translate this into real practice by recalling the procedure steps.

Video-based education has been proven as a useful learning tool to teach various psychomotor skills, while reducing fear and anxiety levels in novice learners. In turn, this increases confidence levels in new learners entering the clinical setting as seen in Appendix E.

3. Methods

3.1 Research Design

A quasi-experimental pretest-posttest design on a single group was utilized for this project. It compared the effectiveness of instructional video simulation on enhancing knowledge and confidence in NATs on the crisis management of VGE in the operating room. This project consisted of four phases:

- Phase 1: Development of an instructional video that simulates the proper management of VGE, a knowledge assessment tool (KAT) (*Appendix A*) to assess non-technical skills knowledge pertaining to VGE, and a student confidence survey (*Appendix A*).

- Phase 2: Distribution of a demographic information questionnaire (*Appendix B*) and pre non-technical skills KAT (*Appendix A*) was first administered to NATs in order to obtain initial baseline data on perceived knowledge and confidence levels on management of a VGE.

- Phase 3: Implementation of an instructional video that simulates proper management of VGE crisis and addresses key information on concept definitions, recognition steps, and treatment options. The video emphasized non-technical skills such as the prevention, recognition, decision-making, and prioritization of a VGE.

- Phase 4: Distribution of post-test non-technical skills KAT and confidence survey (both in *Appendix A*), which is the same initial test from Phase 2, in order to reevaluate any change in non-technical skills knowledge and confidence levels of participants on VGE management.

3.2 Sampling and Sample

Due to an anticipated small sample size, this was a pilot project utilizing convenience sampling to recruit participants based on their accessibility and proximity. For the purpose of this project, the convenience sample consisted of full-time first year NATs from NorthShore University HealthSystem (NSUHS) School of Nurse Anesthesia in Evanston, IL. Participation was voluntary and participants were under no obligation to participate. There were ?? full-time first year NATs who were asked to participate and 14 of them voluntarily participated in this study.

3.3 Setting

The project took place at NSUHS, Evanston Hospital in Evanston, IL on Tuesday, November 20, 2018. Following the NSUHS scheduled class time, first year NATs were asked to voluntarily participate in the project following in the classroom. Desks and audio-visual equipment were readily available in the classroom for delivery of the instructional video and written questionnaires.

3.4 Instruments

3.4.1 VGE educational video. The study researcher developed a script that was approved for content validity by committee members- Karen Kapanke, DNP, CRNA (assistant program director for the NSUHS School of Nurse Anesthesia) and Ola Wojtowicz, BS, BSN, NREMT, CHSOS, CHSE (simulation lab coordinator at Rush University) and was further validated by an expert panel (consisting of three other school faculty members) to ensure the accuracy content. The Content Validity Index proposed by Polit and Beck (2006) was used. The script's

VGE crisis management content was based off of *Crisis Management in Anesthesiology* by Gaba, Fish, Howard, and Burden (2015). The video was recorded in the NSUHS simulation lab and was eventually used to create a voice-over PowerPoint presentation.

3.4.2 VGE education pre-test and post-test questionnaire (Knowledge Assessment Tool). The pre-test and post-test questionnaire served as a KAT (*Appendix A*) that was used to determine any changes in NAT knowledge or confidence levels. The KAT was developed by the study researchers and included a demographic survey (*Appendix B*) that preceded the pre-test. The demographic survey determined the volunteer's gender, age group, ethnicity, years of Intensive Care Unit (ICU) experience prior to starting anesthesia school, current year in the program, and personal opinion regarding video-education. The pre-test/post-test questionnaire consisted of 22-item questions presented in a multiple choice and fill-in-the-blank format. The exact same test was administered before and after the presentation of the VGE educational video in order to obtain baseline knowledge and confidence levels and detect for any changes after the proposed intervention. The KAT was submitted to a total of five expert panel members for approval to ensure content validity. Recommendations for revision were made by the expert panel and the tool was adjusted accordingly and re-submitted for validation.

3.4.3 Validity and reliability. To achieve internal validity and reliability of the project and control confounding characteristics that may interfere, the following steps were taken. The pretest-posttest design had a preset time limit of fifteen minutes to complete the pretest and fifteen minutes to complete the posttest, which prevented volunteers from having recall bias. To eliminate variability, a specific homogenous sample was utilized. First-year NATs were specifically being recruited (over medical students or other healthcare students) to participate in this project. All content presented in the video education tool, pretest, and posttest was supported by literature and the content was validated and approved by an expert panel.

3.5 Recruitment Procedures

A recruitment e-mail (*Appendix C*) was sent to first-year NATs enrolled at the NSUHS School of Nurse Anesthesia prior to project implementation. This e-mail was used to recruit study participants to stay and participate in the project following their scheduled class time. The project purpose and research objectives were stated in the e-mail as well as a request for participation. Study participants were informed that the project is confidential, voluntary, and that they could withdraw at any time.

3.6 Ethical Considerations

In order to ensure human subjects' protection and maintain ethical conduct, the study researchers of this project completed Collaborative Institutional Training Initiative (CITI) training on April 8th, 2017. This project received Institutional Review Board approval by NSUHS and DePaul University under exempt review. A recruitment email was distributed to the NSUHS NATs by a third party DNP project committee chair member to prevent study researcher's involvement. Participants were informed via the recruitment email, as well as prior to the project intervention, that their participation was voluntary and that they may choose to leave the project at any time. The project avoided personal identifiers and maintained confidentiality throughout the process.

3.7 Data Collection Procedures

An e-mail was sent to the NSUHS NATs by a third party DNP project committee chair member on behalf of the study researchers to follow their class on November 20th. Each participant was distributed two separate, randomized, numerically coded manila envelopes to ensure confidentiality. The first envelope contained a demographic survey and the pre- test non-technical skills KAT. The second envelope contained the post-test non-technical skills KAT. Participants were instructed to open the first manila envelope and complete the enclosed demographic survey and pre-test within the allotted 15-minute time frame. Upon completion of the survey and pre-test, the participants returned them back into the original, first manila envelope which were collected by the study researchers. Next, a 10-minute instructional video on VGE crisis management was presented to the participants. Following the instructional video, the participants were asked to open the second envelope and complete the post-test non-technical skills KAT in the allotted 15-minutes. After completing the post-test they were instructed to place the post-test into the original manila envelope to be collected by the researchers.

3.8 Data Analysis

Data was analyzed using International Business Machines (IBM) Statistical Package for Social Sciences (SPSS) Version 25 (IBM, 2018) to determine the impact of the video education on NAT knowledge and confidence levels related to VGE crisis management. Descriptive statistics were used to summarize the sociodemographic characteristics of the NAT participants. The demographic variables were grouped categorically and included: gender, age, race, and years of critical care experience. Demographics variables are summarized in Table 1. A Wilcoxon Signed Matched-Pairs Ranks Test was used to compare the median pre-test scores with the median post-test scores before and after watching the instructional video simulation (Table 3). The Wilcoxon Signed Matched-Pairs Ranks Test was utilized because the data collected was not normally distributed (Kellar & Kelvin, 2013). It

tested the null hypothesis that there is no difference in median scores for knowledge of non-technical skills involving recognition, decision-making, and prioritization during a VGE between pre and post-instructional video implementation. In order to investigate internal consistency of the developed non-technical skills KAT, Kuder-Richardson (KR)-20 statistics was used to approximate the reliability of the instrument (Polit & Beck, 2006). When using the KR-20, 'knowledge' the attribute was measured as the binary outcome.

4. Results

A sample of 14 first year NATs participated in the study and their data was used to determine the effectiveness of a video-based tool on knowledge and confidence levels regarding prevention, recognition, decision-making, and prioritization during a VGE. The participants' demographic data including gender, age, race, and years of critical care experience were reported (Table 1). The majority of study participants were female (57.1%: 8 out of 14), under 30 years old (64.2%: 9 out of 14), Caucasian (71.4%: 10 out of 14). Asian/Pacific Islander accounted for 28.6% (4 out of 14), and almost half had 2-3 years of ICU experience (42.9%: 6 out of 14).

Descriptive statistics including minimum and maximum scores, mean, standard deviation, and skewness statistics for the twenty variables in the Non-Technical Skills KAT can be found in Tables 2 and 3. Following exposure to the video, the mean score increased with every category assessed best illustrated in Figures 2 and 3. The mean prevention score improved from a pre-test score of M=1.79 (SD=0.89) to M=2.79 with a (SD=0.42); the recognition score improved from M=1.07 (SD=0.91) to M=3.57 (SD=0.51); and the decision-making score improved from M=2.00 (SD=1.24) to M=4.00 (SD=0) because everyone got the correct answer. The prioritization section improved from a mean pre-test of M=2.50 (SD=1.50) and improved to M=6.79 (SD=1.92). The overall total score mean improved from a pre-test score of M=7.36 (SD=2.240) to a post-test score of M=17.14 (SD=2.070).

Following exposure to the video the mean score increased in regards to confidence in identifying, managing, and learning crisis management skills through video education illustrated in Figure 3. The mean pre-test value for confidence in identification increased from M=2.43 (SD=1.505) to M=3.43 (SD=0.514); the confidence in managing score increased from M=2.07 (SD=1.492) to M=3.14 (SD=0.770); and confidence in learning increased from M=3.29 (SD=0.469) to M=3.64 (SD=0.497).

In order to determine the reliability of the KAT, a KR-20 test was calculated utilizing pre and post-test mean scores. Where applicable the KR-20 statistics test is presented in Table 4. The pre-test was below the desired 0.5 KR-20 coefficient value of KR-20=0.373. The post-test KAT was found to have good reliability and showed a

discriminatory power of the test questions with a KR-20 coefficient value=0.678 (Statistics How To, 2019). The

reliability of the Confidence subscale was found to be below .70 which showed poor consistency of the four items in

measuring the participants' confidence level. Because of the lack of reliability of the Confidence subscale, the data

collected are not valid and are not reported in this paper (DeVellis, 2017).

A Wilcoxon Signed Matched-Pairs Ranks Test was used to test the null hypothesis that there is no

difference in median scores for knowledge of non-technical skills involving recognition, decision-making, and

prioritization during a VGE between pre and post-instructional video implementation. Table 5 presents the results

from calculated Wilcoxon Signed Matched-Pairs Ranks Test. The results indicated that the median post-test scores

were statistically significantly higher than the median pre-test scores [Z=-3.301; p=0.001 (2-tailed)].

5. Discussion

NATs that participated in the study gained knowledge and confidence from pre and post video

implementation. . The mean scores improved in every knowledge category (prevention, recognition, decision-

making, and prioritization) and confidence category (identification, management, and learning crisis management).

A Wilcoxon Signed Matched-Pairs Ranks Test determined that the median post-test scores of the KAT significantly

increased compared to the pre-test scores after video implementation proving statistically significant. The

instructional video improved knowledge and confidence among NATs for the management of VGE as demonstrated

by significantly increased mean score [Z=-3.301; p=0.001 (2-tailed)]. This demonstrated that video simulation

education is an effective method of learning crisis management.

A Kuder-Richardson (KR-20) formula was calculated to assess internal consistency and reliability of the

KAT. The non-technical skills KAT results proved reliable in the post-test because the KR-20 score was above 0.5

(KR=0.678). The computed KR-20 results for the post-test establishes validity and reliability of the non-technical

skills KAT among first-year NATs.

Figure 1 illustrates the significant change in mean pre-test and post-test scores after video implementation

with a significant shift from positive skewness=1.250 on the pre-test to a negative skewness=-1.253 on the post-test.

Due to the majority of scores being incorrect in the pre-test the histogram demonstrates a right skew of the data

(Figure 1). However, the majority of study participants scored significantly higher on the post-test creating a left

skew (Figure 1).

The results of this study suggest that video based simulation education is an essential tool to improve knowledge and confidence in the NAT as they prepare for entry into clinical practice. This method of learning is helpful when students are required to recognize and manage rare crises that they are often not exposed to in their clinical settings. Ultimately, this promotes patient safety and reduces sentinel events by improving a NAT's prevention, recognition, decision-making, and prioritization of crisis management.

5.1 Limitations

This project had a small convenience sample limited to one cohort of NAT's in their first year of training prior to any anesthesia related clinical exposure. Only participants known by the researchers were utilized. In addition, this study did not assess other first year NAT's in other nurse anesthesia programs, thus the study has a decreased external validity due to a small convenience sample size. Therefore, the findings of this study have limited generalizability. The limited data set prevented the use of inferential statistical analysis, and only allowed for descriptive statistics.

This study only assessed one educational modality to improve crisis management skills, competence, and confidence in the NAT. It did not look at other methods of learning such as traditional lecture style or live simulation. This also contributed to the studies limited generalizability.

Utilizing a pre-test/post-test design allowed the opportunity to assess for improvements in knowledge and confidence levels after video implementation; however, it also proposes a threat to internal validity. This is due to the increased possibility of recall bias by utilizing an identical pre-test and post-test KAT. This research design could result in diminished definitive findings due to the short period of time in which the study was conducted.

A KR-20 statistical analysis was performed to assess the reliability of each category of the KAT distributed. The results were not reliable in the pre-test because there is minimal variability on the categories assesses. However, the post-test KR-20 was reliable with a score greater than 0.5.

5.2 Recommendations for Future Research

Multi-media learning improves clinical readiness and promotes active engagement through audio-visual sensory stimulation. Further research can build upon current findings by assessing other educational modalities such as live simulation or traditional lecture. This will allow for another subset to be analyzed in comparison to video-based education.

Another opportunity is to assess long-term retention of crisis management by utilizing video-based education as an adjunct to traditional lecture style learning. The strength of the study may improve by assessing retention with a future study through implementing a secondary post-test at a later date.

Future studies should aim for obtaining a larger sample size and control group to allow for improved randomization, decreased selection bias, and increased generalizability. This also would allow for a useful population subset analysis, which can be accomplished by assessing multiple nurse anesthesia programs first year students.

6. Conclusion

Crisis management is an essential skill required of CRNAs and depends on the practitioner's ability to identify individuals at risk, incorporate prevention strategies, recognize key signs and symptoms, incorporate appropriate decision-making skills, and prioritize actions. All of these non-technical skills are essential for patient care and safety as NAT's enter the anesthesia arena. Each student learner is unique and requires material to be taught in more than one way. By incorporating audio, visual, and written word in video simulations, educators will be able to reach a diverse group of student learners. The goal is to engage student learners, improve knowledge retention, and increase confidence among novice NATs as they enter clinical practice. An instructional video can be used as an adjunct to didactic courses in the nurse anesthesia curriculum. Lastly, this study also contributed to the promotion of patient safety because it has the ability to lower the incidence of VGE and the associated morbidity and mortality rates by improving NATs knowledge and confidence levels regarding prevention, recognition, decision-making, and prioritization in crisis management.

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Appendix A.

Pre-Video VGE Knowledge Assessment Tool Survey

Please complete the following questions as they relate to the prevention, recognition, decision-making, and prioritization of venous gas embolism. This survey is voluntary and anonymous. Completion of this survey should take approximately 15 minutes.

Pre-Video Survey

Prevention

1. What is the optimal position during placement of a central venous catheter in order to decrease risk of a venous gas embolism?
   a. Reverse Trendelenburg
   b. Trendelenburg
   c. Sitting
   d. Lithotomy
2. Which anesthetic gas should be avoided in cases at high risk for venous gas embolism?
   a. Isoflurane
   b. Sevoflurane
   c. Desflurane
   d. N2O
3. Which monitoring device should be considered prior to surgery for patients at increased risk for venous gas embolus?
   a. Arterial Line
   b. Central Venous Catheter
   c. Bispectral Analysis
   d. Peripheral Nerve Stimulator

Recognition

4. Which of the following surgical procedures place patients at an increased risk for venous gas embolism? **(Select two)**
   a. Sitting Craniotomy
   b. Knee Arthroscopy
   c. Laparoscopic Cholecystectomy
   d. Total Abdominal Hysterectomy
   e. Parathyroidectomy
5. Which of the following patient positions place the patient at an increased risk for venous gas embolism?
   a. Supine
   b. Prone
   c. Trendelenburg
   d. Beach Chair
6. Which hemodynamic changes would you notice during a venous gas embolism? (**Select two)**
   a. Hypotension
   b. Hypertension
   c. Presence of a "mill wheel" murmur
   d. Decrease in CVP
7. Which pulmonary sign/symptom would you notice during a venous gas embolism?
   a. Increased $EtCO_2$
   b. Decreased $EtCO_2$
   c. Decreased EtN_2
   d. Absence of breath sounds over the left lung fields

Decision-Making

8. What is the **MOST** sensitive monitor used to detect a venous gas embolism?
    a. Echocardiogram
    b. TEE
    c. CT Scan
    d. Esophageal Stethoscope
9. Which of the following patient presentations would help confirm the diagnosis of a venous gas embolism?
    a. BP 120/80, EtCO$_2$ 35 mmHg, CVP 2 mmHg
    b. BP 85/50, EtCO$_2$ 20 mmHg, CVP 12 mmHg
    c. BP 140/80, EtCO$_2$ 20 mmHg, CVP 8 mmHg
    d. BP 85/50, EtCO$_2$ 55 mmHg, CVP 6 mmHg
10. At what point during a surgical procedure using a high-pressure gas source, is a patient **MOST** at risk for developing a venous gas embolism?
    a. After surgical incision
    b. During insufflation
    c. During position changes
    d. Closure of fascia
11. Prompt recognition and action are important during crisis management of a venous gas embolism because the ultimate sequela results in:
    a. Hypoxia
    b. Pneumothorax
    c. Hemorrhage
    d. Cardiovascular collapse

Prioritization

12. ___ Fluids wide open; provide intravenous inotropic agent support
13. ___ Position patient in steep, head-down, left-lateral decubitus position
14. ___ 100% FiO$_2$ and N$_2$O off
15. ___ Call for help
16. ___ Notify surgeon immediately of a possible VGE and turn off all pressurized gas sources
17. ___ Attempt to aspirate gas from a central venous catheter
18. ___ If hemodynamic compromise is severe, perform CPR and follow cardiac arrest algorithm
19. ___ Ask the surgeon to flood the surgical field with saline or pack the wound with saline-soaked sponges

Confidence

20. How confident are you in identifying a venous gas embolism?
    a. Very confident
    b. Somewhat confident
    c. Somewhat unconfident
    d. Not confident at all
21. How confident are you in managing a venous gas embolism?
    a. Very confident
    b. Somewhat confident
    c. Somewhat unconfident
    d. Not confident at all
22. I have more confidence learning crisis management skills through video education than traditional face-to-face lecture.
    a. Agree
    b. Somewhat agree
    c. Somewhat disagree
    d. Disagree

Post-Video VGE Knowledge Assessment Tool Survey

Please complete the following questions as they relate to the prevention, recognition, decision-making, and prioritization of venous gas embolism. This survey is voluntary and anonymous. Completion of this survey should take approximately 15 minutes.

Post-Video Survey

Prevention

1. What is the optimal position during placement of a central venous catheter in order to decrease risk of a venous gas embolism?
    a. Reverse Trendelenburg
    b. Trendelenburg
    c. Sitting
    d. Lithotomy
2. Which anesthetic gas should be avoided in cases at high risk for venous gas embolism?
    a. Isoflurane
    b. Sevoflurane
    c. Desflurane
    d. N2O
3. Which monitoring device should be considered prior to surgery for patients at increased risk for venous gas embolus?
    a. Arterial Line
    b. Central Venous Catheter
    c. Bispectral Analysis
    d. Peripheral Nerve Stimulator

Recognition

4. Which of the following surgical procedures place patients at an increased risk for venous gas embolism? **(Select two)**
    a. Sitting Craniotomy
    b. Knee Arthroscopy
    c. Laparoscopic Cholecystectomy
    d. Total Abdominal Hysterectomy
    e. Parathyroidectomy
5. Which of the following patient positions place the patient at an increased risk for venous gas embolism?
    a. Supine
    b. Prone
    c. Trendelenburg
    d. Beach Chair
6. Which hemodynamic changes would you notice during a venous gas embolism? (**Select two)**
    a. Hypotension
    b. Hypertension
    c. Presence of a "mill wheel" murmur
    d. Decrease in CVP
7. Which pulmonary sign/symptom would you notice during a venous gas embolism?
    a. Increased $EtCO_2$
    b. Decreased $EtCO_2$
    c. Decreased EtN_2
    d. Absence of breath sounds over the left lung fields

Decision-Making

8. What is the **MOST** sensitive monitor used to detect a venous gas embolism?

      a. Echocardiogram
      b. TEE
      c. CT Scan
      d. Esophageal Stethoscope

9. Which of the following patient presentations would help confirm the diagnosis of a venous gas embolism?
      a. BP 120/80, $EtCO_2$ 35 mmHg, CVP 2 mmHg
      b. BP 85/50, $EtCO_2$ 20 mmHg, CVP 12 mmHg
      c. BP 140/80, $EtCO_2$ 20 mmHg, CVP 8 mmHg
      d. BP 85/50, $EtCO_2$ 55 mmHg, CVP 6 mmHg

10. At what point during a surgical procedure using a high-pressure gas source, is a patient **MOST** at risk for developing a venous gas embolism?
      a. After surgical incision
      b. During insufflation
      c. During position changes
      d. Closure of fascia

11. Prompt recognition and action are important during crisis management of a venous gas embolism because the ultimate sequela results in:
      a. Hypoxia
      b. Pneumothorax
      c. Hemorrhage
      d. Cardiovascular collapse

Prioritization

12. ___ Fluids wide open; provide intravenous inotropic agent support
13. ___ Position patient in steep, head-down, left-lateral decubitus position
14. ___ 100% FiO_2 and N_2O off
15. ___ Call for help
16. ___ Notify surgeon immediately of a possible VGE and turn off all pressurized gas sources
17. ___ Attempt to aspirate gas from a central venous catheter
18. ___ If hemodynamic compromise is severe, perform CPR and follow cardiac arrest algorithm
19. ___ Ask the surgeon to flood the surgical field with saline or pack the wound with saline-soaked sponges

Confidence

20. How confident are you in identifying a venous gas embolism?
      a. Very confident
      b. Somewhat confident
      c. Somewhat unconfident
      d. Not confident at all

21. How confident are you in managing a venous gas embolism?
      a. Very confident
      b. Somewhat confident
      c. Somewhat unconfident
      d. Not confident at all

22. I have more confidence learning crisis management skills through video education than traditional face-to-face lecture.
      a. Agree
      b. Somewhat agree
      c. Somewhat disagree
      d. Disagree

Answer Key (*Will be coded in SPSS as 0=wrong answer; 1=correct answer*)
1. B
2. D
3. B

4. A&C
5. D
6. A&C
7. B
8. B
9. B
10. B
11. D

Correct Order

12. Notify surgeon immediately of a possible VGE and turn off all pressurized gas sources
13. Call for help
14. 100% FiO$_2$ and N$_2$O off
15. Ask the surgeon to flood the surgical field with saline or pack wound with saline soaked sponges
16. Position patient in steep head down left lateral decubitus
17. Fluids wide open and provide intravenous inotropic agent support
18. Attempt to aspirate gas from a central venous catheter
19. If hemodynamic compromise is severe perform CPR and follow cardiac arrest algorithm

Appendix B: Demographic Survey

Please complete the following survey. Your participation is voluntary and anonymous. This survey should take approximately 3 minutes.

1. What is your gender?
    1. Male
    2. Female
    3. Prefer not to answer
2. What is your age group?
    1. 20-25
    2. 26-30
    3. 31-35
    4. 36-40
    5. 41+
3. What is your ethnic origin?
    1. White
    2. Hispanic/Latino
    3. Black/African American
    4. Native American/American Indian
    5. Asian/Pacific Islander
    6. Other
    7. Prefer not to answer
4. How many years of ICU experience did you have prior to starting anesthesia school?
    1. 1 year
    2. 2-3 years
    3. 4-5 years
    4. >5 years
5. Where are you currently in the Nurse Anesthesia Trainee (NAT) Program?
    1. NAT-I
    2. NAT-II
    3. NAT-III
6. Do you believe video-learning improves retention of information?
    1. Yes
    2. No

Appendix C: Recruitment E-mail

Dear NAT,

On Tuesday, November 20, 2018, you are being asked to participate in a research study as a part of a DNP project. You are being asked to attend a presentation to watch an educational video simulation on the crisis management of Venous Gas Embolisms (VGE). The purpose of this study is to determine whether or not a video simulation will improve your level of knowledge in the prevention, recognition, decision-making, and prioritization during a VGE crisis. Additionally, confidence levels regarding VGE management will be assessed. You will be asked to complete three surveys: two prior to the video and one afterwards. The first is a demographics survey that determines your gender, age range, years of critical care experience, current level in the program, and opinion regarding video-based learning. These surveys will be anonymous, and you may choose to skip any questions you prefer not to answer. You will be allotted fifteen minutes to complete each of the pre and post-video surveys. The video itself will be approximately fifteen minutes long.

You may choose not to participate and/or leave the study at any point. Because of the anonymous nature of the surveys, we are unable to remove your responses from the data after they have been submitted. Attached is the information sheet for participants in research, which explains our project in more detail. Please review this information prior to participating in the study. We thank you in advance for your participation.

Sincerely,

Danielle Balzano MSN, RN & Brianna McNamara BSN, RN

Appendix D: Venous Gas Embolism Instructional Video Script

Instructional Video Script for Prevention, Recognition, Decision-making, and Prioritization during Venous Gas Embolism

Note: Information derived from Gaba, D. M., Fish, K. J., Howard, S. K., & Burden, A. R. (2015). *Crisis management in anesthesiology* (2nd ed.). Philadelphia, PA: Elsevier Saunders.

VIDEO CONTENT AND SCRIPT	
Screen 1: **Introduction**	**Evaluating the Effectiveness of Video-based Education of Venous Gas Embolism to Improve Knowledge and Confidence Among Nurse Anesthesia Trainees** **By: Danielle Balzano and Brianna McNamara**
Screen 2:	**Teaching Objectives** Following this instructional video, the nurse anesthesia trainee will be able to: 1. Identify prevention strategies of Venous Gas Embolism (VGE) 2. Formulate differential diagnoses to recognize VGE 3. Identify key signs and symptoms of VGE to improve decision-making process 4. Prioritize the correct sequence of steps for management of VGE
Screen 3:	(Slide displaying a picture of the four components that will be addressed during the video) Voice over: *This video focuses on identifying prevention strategies, recognition, decision-making, and prioritization during a VGE.*
Screen 4:	**Venous Gas Embolism Definition** (Slide displaying a picture of VGE traveling through right side of heart into pulmonary vessel) Voice over: *A VGE is defined as the entrainment of a gas (most commonly air or CO2) into venous circulation that ultimately travels to the right side of the heart or pulmonary vessels.* Voice over: *There are several signs and symptoms that help to identify when a VGE is occurring* **VGE Signs & Symptoms** • The most sensitive test to diagnose a VGE is a TEE • Presence of a "Mill wheel" murmur • Hypotension • Decreased EtCO2 • Increased EtN2 • Increase in CVP • Hypoxia • The ultimate sequela is cardiovascular collapse
Screen 5:	**Typical Clinical Situations Associated with VGE** Voice over: *It is important for the nurse anesthetist to recognize the clinical situations that can predispose a patient to developing a VGE. (Read through list)* **Typical Clinical Situations Associated with VGE** • Surgical procedures requiring positioning in which the operative site is above the level of the heart (ex: sitting craniotomy and shoulder arthroscopy) • Surgical procedures that require insufflation (ex: laparoscopic surgery) • Invasive procedures that expose an open vein to the atmosphere (ex: CVP placement or disconnection) • Invasive procedures that require patient connected to a high-pressured gas source

Screen 6:	**Prevention Strategies**
	Voice over: *It is important for anesthesia providers to identify clinical scenarios that predispose patients at risk for a VGE so that the appropriate preventative measures can be taken. (Read through list)*
	Prevention Strategies
	• If possible, avoid positioning patient in which the operative site or central line cannulation is above the level of the heart
	• When placing or removing a central line, place the patient in the Trendelenburg position
	• Remove all air from IV fluids and lines prior to pressurized infusions
	• Avoid administration of N_2O to patients at risk of VGE
	• Consider placement of a central venous catheter prior to surgery start for patients at increased risk for VGE
Screen 7:	**Clinical Scenario Introduction**
	Voiceover: *The following scenario will be used to illustrate the proper recognition, decision-making, and prioritization during a VGE. Mr. Banks is a 60 year old 80kg male undergoing a laparoscopic cholecystectomy. Preoperatively his blood pressure was 146/82, heart rate 64, and oxygen saturation of 99% on room air. His history includes hypertension, non-insulin dependent diabetes, and hypothyroidism. After induction, the patient is intubated and placed on 1 MAC of Sevoflurane on 1L of Oxygen and 1L of Air for maintenance of general anesthesia. Surgical time-out has been completed and the surgeon has placed the Veress needle and is ready to begin abdominal insufflation.*
	Clinical Scenario
	• **Patient Info:** 60 year old male, 80kg
	• **Procedure:** Laparoscopic Cholecystectomy
	• **Preoperative Vitals**: BP=146/82, HR=64, SpO2= 99%
	• **PMH:** HTN, Non-Insulin Dependent Diabetes, Hypothyroidism
	• **Anesthetic Plan:** General Anesthesia Endotracheal Tube (GETA) with Sevoflurane (O2 at 1LPM, Air at 1LPM)
	• **Surgical Considerations:** Trocar insertion and abdominal insufflation
Screen 8: Split screen will show reenactment of the clinical scenario while also displaying the monitoring devices	**Clinical Scenario Video**
	Surgeon speaking to circulating nurse: *Now that Veress needle is placed please begin insufflating and set to a pressure of 15mmHg.*
	Monitor (before insufflation): *BP= 126/84, HR= 68, SpO2= 98%, EtCO2= 35mmHg*
	Video is Paused to display monitor after insufflation
	Monitor (after insufflation): *BP= 85/50, HR= 88, SpO2= 86%, EtCO2= 20mmHg*
	Voice Over: (paused on monitor screen after insufflation) *During the recognition process, the nurse anesthetist monitors the patients response to insufflation and identifies that there has been a drop in blood pressure, increase in HR, decrease in O2 saturation, and significant decrease in EtCO2. She recognizes that the patient may be experiencing a VGE due to the use of a high pressurized gas source.*
Screen 9: Split screen will show reenactment of clinical scenario while also displaying prioritization	**Clinical Scenario Video**
	Voiceover: *The prioritization of the nurse anesthetists' actions for a VGE is as follows: first, notify the surgeon immediately of a possible VGE and turn off all pressurized gas sources while the anesthetists call for help.*
	(Split screen shows a close up of this action taking place.)
	Voiceover: *Second, the patient is placed on 100% FiO2 and N2O would be turned off if being*

steps	*utilized.*
	(Split screen shows a close up of this action taking place)
	Voiceover: *Third, in the event of a VGE the surgeon will flood the surgical field with saline or pack the wound with saline soaked sponges.*
	(Split screen shows a close up of this action taking place)
	Voiceover: *Fourth, the patient should be positioned in a steep head down left lateral decubitus*
	(Split screen shows a close up of this action taking place)
	Voiceover: *Fifth, IV fluids are wide open and IV inotropic support is provided to support blood pressure and patient hemodynamics.*
	(Split screen shows a close up of this action taking place)
	Voiceover: *Sixth, once help arrives designate an anesthesia provider to place a central venous catheter and attempt to aspirate any gas.*
	(Split Screen shows a close up of this action).
	Voiceover: *Lastly, if the above efforts have not been successful and hemodynamic compromise is severe, the next steps are to perform CPR and follow the cardiac arrest algorithm.*
	Prioritization of Actions for VGE (displayed on split screen while other screen shows close up of each action) 1. Notify surgeon immediately of a possible VGE and turn off all pressurized gas sources 2. Call for help 3. 100% FiO2 and N2O off 4. Ask the surgeon to flood the surgical field with saline or pack wound with saline soaked sponges 5. Position patient in steep head down left lateral decubitus 6. Fluids wide open and provide intravenous inotropic agent support 7. Attempt to aspirate gas from a central venous catheter 8. If hemodynamic compromise is severe perform CPR and follow cardiac arrest algorithm
Screen 10: **Split screen will show** **reenactment of** **the clinical** **scenario while** **also displaying** **the monitoring** **devices**	Voice over: *Using the decision making and prioritization skills just described, the patient's VGE can be managed in real time as follows.* (Video is unpaused and clinical scenario begins) Monitor (before insufflation): *BP= 126/84, HR= 68, SpO2= 98%, EtCO2= 35mmHg* Surgeon speaking to circulating nurse: *Now that the Veress needle is placed, please begin insufflating and set to a pressure of 15mmHg* Monitor (after insufflation): *BP= 85/50, HR= 88, SpO2= 86%, EtCO2= 20mmHg* Nurse Anesthetist to surgeon: *The patient is experiencing a change in vital signs stop*

insufflation and turn off all pressurized gas sources; I think we may have a VGE!

Nurse Anesthetist to Circulating nurse: *Please call Dr. Johnson stat to OR 5*

Nurse Anesthetist: *I am going to turn the FiO2 to 100% and confirm that N2O is off*

Surgeon: *We have stopped insufflation and will flood the surgical field with saline to eliminate any origin of gas entry*

Nurse Anesthetist: *I am going to position the patient in steep Trendelenburg*

Surgeon: *Lets also turn the patient into a left lateral decubitus position*

Nurse Anesthetist: *I am going to run the fluids wide open and begin inotropic IV Support.* (The nurse anesthetist pushes phenylephrine and begins a phenylephrine infusion).

(Anesthesiologist Dr. Johnson arrives to help)

Nurse Anesthetist to Dr. Johnson: *While I support the patients hemodynamics Dr. Edwards can you please place a central venous catheter and attempt to aspirate any gas that has traveled to the right side of the heart*

Monitor displays: *BP= 64/48, Heart Rhythm: Asystole, SpO2= 70%, EtCO2= 15mmHg*

Nurse Anesthetist: (checks for a pulse) *I have no pulse begin CPR and follow cardiac arrest algorithm*

End of Video Scenario

Screen 11:

VGE Recap

Voice over: *Let's review how the non-technical skills of prevention, recognition, decision making, and prioritization can be used to manage the scenario of a VGE.*
(read through the recap)

Prevention
- Consider a CVC for patients at increased risk
- Avoid positioning patient in which the operative site or central line cannulation is above the level of the heart
- Avoid N2O for patients at increased risk

Recognition
- Hypotension
- Decreased O2 Saturations
- Decreased EtCO2
- Increased EtN2
- Risk Factors: type of surgery (laparoscopic procedures, sitting craniotomy), patient position (beach chair or sitting)

Decision Making:
- Presence of a "mill wheel" murmur
- Detection of "Fireflies" on TEE
- Monitor vital signs during insufflation
- Be cautious of Cardiovascular collapse at the ultimate sequela

Prioritization
1. Notify surgeon immediately of a possible VGE and turn off all pressurized gas sources
2. Call for help

3. 100% FiO2 and N2O off
4. Ask the surgeon to flood the surgical field with saline or pack wound with saline soaked sponges
5. Position patient in steep head down left lateral decubitus
6. Fluids wide open and provide intravenous inotropic agent support
7. Attempt to aspirate gas from a central venous catheter
8. If hemodynamic compromise is severe perform CPR and follow cardiac arrest algorithm

Appendix E: Evidence-Based Table 1. Efficacy of Simulation and Video-Based Education

Table 1: Efficacy of Simulation and Video-Based Education						
Author & Year	Study Objectives	Methods (Design, Sample Size, Setting, Human Subject Issues)	Instruments Used to Measure the Construct(s)	Statistics Used for Data Analysis	Study Findings	Conclusion
Sharpnack, Goliat, Baker, Rogers, and Shockey (2013)	The purpose of this study was to examine the effectiveness of using video-taped scenario simulations on the critical thinking scores and quality and safety competencies of nursing students in	A pretest-post test quasi-experimental design. A convenience sample of 54 baccalaureate nursing students enrolled in a senior leadership course. Setting: Midwestern College	The Creighton Simulation Evaluation Instrument (C-SEI) was used to evaluate assessment, communication, critical thinking, and technical skills.	A paired samples t test to compare the mean pretest score with the mean posttest score.	Statistically significant differences between mean pre test and post test scores (7.57 on the pretest and 19.24 on the posttest) in nursing students (p = 0.0001) were found.	Project findings support the use of video scenarios for the application of theoretical knowledge to clinical situations, promotion of critical thinking skills and development of quality, safety and leadership competencies.
Woodworth, Chen, and Horn (2014)	To determine the effectiveness of a short educational video and simulation on improvement of ultrasound (US) image acquisition and interpretatio	Prospective, randomized study. 28 anesthesia residents and community anesthesiologists with varied US experiences were randomized to teaching	Written test consisting of 30 questions presenting US images of the posterior thigh and asking subjects to identify an anatomic structure (nerve, bone, muscle, or	2-sided t-test to compare the mean scores in the written test Kendall tau rank correlation to assess the ordinal association between written test scores and live US scanning scores	Pretest written test scores correlated with reported US block experience (Kendall tau rank r = 0.47) and with live US scanning scores (r = 0.64). The teaching video and simulation significantly improved scores on the written examination (P = 0.001); however, they did not	A short educational video with interactive simulation significantly improved knowledge of US anatomy, but failed to improve hands-on performance of US scanning to localize the nerve.

n skills.	video with interactive simulation or sham video groups. Setting: University Medical Center Informed consent was obtained from the human subjects.	vessel). In addition, a 10-point Likert-type scale was used to rate subject's confidence with US-guided blocks after the intervention.		significantly improve the live US scanning skills.	
McLain, Biddle, and Cotter (2012)	The purpose of this study was to compare traditional methods of instruction to the use of audiovisual patient safety vignettes in terms of their impact on Student registered nurse anesthetists' recall and sub-sequent clinical performance.	Randomized controlled trial that included a dual crossover design. 24 student registered nurse anesthetists with no prior exposure to anesthesia equipment or delivery systems were randomly divided into two groups Setting: Virginia and Alabama University Setting	A pre-test and post-test knowledge assessment comparison was done to evaluate recall of educational content. Simulation performance was measured at point of-learning and 2 weeks post-instruction.	A 1-way analysis of variance was performed to evaluate differences in knowledge mean scores.	Pre test/post test knowledge changes revealed significant results in students' score improvements for group 2 (P = .001). Clinical performance measures revealed mixed results for anesthesia machine unidirectional valve check and suction device functionality.	This study demonstrated that under the studied conditions, teaching methods had an impact on some areas of clinical performance. The results supported the hypothesis that recall was greater in the crisis-oriented, anesthesia patient safety vignette group (intervention group) as opposed to the written case study group (control group).
Wirihana, Craft, Christensen, and Bakon	To evaluate the efficacy of the use of one-way video as a	This review consisted of multiple literature searches	Search criteria were limited to a 7-year time frame and	N/A	**N/A**	There is continued support for hybrid pedagogical models that combine the use of innovative teaching technologies such as video

| (2017) | learning approach in nursing education. | from five databases, namely Scopus, ProQuest, PUBMED, Medline, and Science Direct.

A total of 20 studies were incorporated in the final product. | with full text available, from peer reviewed publications in English.

Critical analysis utilizing the critical appraisal skills program checklist (CASP) of the identified material established validity and robustness of methodology of the included papers. | | | streaming with traditional methods such as face to face lectures. The use of video as a learning tool if effectively implemented can provide students with an alternative option of learning support. |
|---|---|---|---|---|---|---|
| Chi, Pickrell, and Riedy (2014) | Objective was to compare outcomes associated with video and paper cases used in an introductory public health dentistry course. | Retrospective cohort study with a historical control group

n= 247 University of Washington School of Dentistry predoctoral dental students

Experimental group (n=63) first year dental students receiving video case; Historical control | Survey based | One-way ANOVA was used to test the hypotheses across ten cognitive, two affective, and one general assessment measures (α=0.05). | Students in the video group reported a significantly higher overall mean effectiveness score than students in the paper group (p<0.001). Video cases were also associated with significantly higher mean scores across the remaining twelve measures and were effective in helping students achieve cognitive and affective goals. | Compared to paper cases, video cases significantly improved cognitive, affective, and overall learning outcomes for dental students. |

		group (n=184) second-, third-, and fourth-year dental students receiving paper case.				
Murphy (2017)	Examined the differences in clinical reasoning and perceptions of learning experience of students who completed text-based case activities with students who completed comprehensive video case studies and associated learning activities targeting clinical reasoning.	Complementary mixed-methods study Examined 60 entry-level occupational therapy (OT) students enrolled in a mid-Atlantic university. Either video or text cases were included as part of a physical rehabilitation course over 2 years as part of the curriculum. Students were given the choice of participation in the research.	Participants completed the Health Science Reasoning Test to measure clinical reasoning and the Self Assessment of Clinical Reflection and Reasoning to examine student perceptions of reasoning as a pretest and posttest.	Paired t tests examined the differences in reasoning scores from pretest to posttest in each group. Covariates of age, grade point average, and prior experience in physical rehabilitation were controlled using analysis of covariance to compare posttest scores of the text and video groups. Phenomenological analysis of the interview data explored student engagement and supported understanding of the influence of instructional methods on clinical reasoning.	Quantitative analysis indicated that students using video cases demonstrated statistically significant higher scores in inductive reasoning (p<0.05). The video case group also demonstrated significantly higher induction skills than the text case group. Students in the video case group were able to explain a more detailed and integrated understanding of clinical reasoning than students in the text case group.	Students identified high satisfaction with case-based learning, supported by the literature. However, there were distinct advantages to each type of case-based instructional methods, consistent with investigation in other disciplines. While text cases provided a more structured learning experience, the authenticity of the video cases promoted statistically significant improvements in inductive reasoning and higher student reports of clinical readiness.
Deindl, Schwindt, Berger, and	To evaluate whether video-based education	Quasi-randomized clinical trial	A newborn life support trainer watched all	Specify the statistics used	Watching a self-instructional video improved performance	A self-instructional video significantly improved bag mask PPV performance in inexperienced providers but

Schmölzer (2015)	could improve the quality of bag-mask ventilation performed by inexperienced providers during simulated neonatal resuscitation	cohort study 28 fourth-year medical students were video recorded performing bag-mask ventilation before and after watching a five minute teaching video on the topic	of the recordings and evaluated them. The evaluator was blinded to which (pre or post education) video they were watching		quality scores of both correct head positioning, and the quality of airway maneuvers compared to baseline, however mask leak was not significantly reduced.	did not improve mask leak in a model of neonatal resuscitation.
Jin and Bridges (2014)	To review new and emerging educational technologies in problem-based learning (PBL), with a specific focus on 3 cognate clinical disciplines: medicine, dentistry, and speech and hearing sciences.	Systematic Review The population was limited to postsecondary education, specifically in dentistry, medicine, and speech and hearing sciences, in which PBL was the key educational pedagogy and curriculum design. Of 470 studies, 28 were selected for analysis.	Comprehensive computerized database search of full-text articles published in English from 1996 to 2014 was carried out using 3 databases: ProQuest, Scopus, and EBSCOhost. .	The results were analyzed and synthesized by narrative or quantitative pooling.	Of the final 28 studies, 20 examined applications of various software and digital learning objects, 5 studies examined the application of interactive whiteboards (IWBs) and plasma screens, and 3 explored the application of learning management systems (LMSs) in PBL across the 3 clinical disciplines.	This literature review demonstrates the generally positive effect of educational technologies in PBL. Further research into the various applications of educational technology in PBL curricula is needed to fully realize its potential to enhance problem-based approaches in health sciences education.
Jacobs (2017)	To explore the nursing staff's perception of the	Non-experimental, descriptive study.	Single 8 question Post-test and four-question	Descriptive statistics using frequencies and percentages	Quantitative results for the post-simulation survey showed that 93% of participants	Simulation with video-assisted debriefing offers hospital educators the ability to evaluate team processes and offer

| | benefits of using high-fidelity simulation during mandated obstetrical hemorrhage mock code training. | Convenience sample of 84 members of the nursing staff.

Setting: 220-bed Midwestern medical center with a well-developed simulation program

All participants consented to completing data collection forms and being videotaped during the simulation. | Likert-type survey

Expert raters used a structured tool called the Mayo Clinic High-Performance Teamwork Scale (MHPTS) during the simulation events. | For consistency the researcher conducted all 16 sessions, collected data from the paper forms, and conducted all debriefing sessions recording participants' answers by pen and paper. | agreed or totally agreed that the use of SimMan made the simulation more realistic and enhanced learning and that debriefing and the use of videotaped playback improved their evaluation of team communication. | support to improve teamwork with the ultimate goal of improving patient outcomes during obstetrical hemorrhage. |

Appendix F: Evidence-Based Table on Learners' Attitudes and Confidence Levels After Video-Based

Education

Table 2: Learners' Attitudes and Confidence Levels After Video-Based Education						
Author & Year	**Study Objectives**	**Methods (Design, Sample Size, Setting, Human Subject Issues)**	**Instruments Used to Measure the Construct(s)**	**Statistics Used for Data Analysis**	**Study Findings**	**Conclusion**
Kelly, Lyng, McGrath, and Cannon (2009)	To determine how online learning videos compare with the traditional lecturer demonstration in terms of the outcomes 'knowledge attainment' and 'student performance.' To explore how Year 1 student nurses feel about learning clinical skills through online learning videos.	Multi-method study, randomized control, with a quasi-experimental post-test only control group design. The sample size consisted of four students in the control group and six in the experimental group. Setting: Dublin City University School of Nursing Four students withdrew before the assignment, students not required to	The participants' knowledge and performance was assessed during week 1 during supervision. Performance outcomes were tested by Objective Structured Clinical Examination (OSCE) using standard assessment tools. Volunteer knowledge was tested using a 15-item multiple choice quiz.	Mann Whitney U and Kruskall Wallis H tests	Due to a small sample size and uneven distribution of data, there was no significant difference between the control and experimental groups. Only one third of the male students compared to one half of the female students would like more use of videos for teaching skills.	Instructional videos enhance learning when combined with lecturer demonstration. The authors conclude that instructional CDs were at least as effective as face-to-face demonstration for teaching psychomotor skills

		provide an explanation of reason for withdrawal.				
Bahar, Arsian, Gokgoz, Ak, and Kaya (2017)	To examine the effects of the use of supported educational videos on the nursing student's skills to administer parenteral medication.	Single-blind, randomized controlled, quasi-experimental pretest-posttest trial study design The sample size included 80 first year nursing students, 40 in the control group, and 40 in the experimental group Setting: Turgut Ozal University School of Nursing	A questionnaire and obstructed skill clinical examination (OSCE) tool were used for data collection.	The Mann-Whitney U test and Kruskal-Wallis tests were used to examine and compare the differences in the pre-test, post-test and pre-post-test differences in scores.	The obstructed skill clinical examination posttest skill scores of the experimental group trained with supported educational videos were found to be higher than the control group who received just a demonstration method (116.43 in the experimental group versus 103.18) ($p < 0.05$).	The supported training method used in conjunction with the video training was found to be effective in the parenteral medication skills training. Educational videos, which are considered innovative educational materials, have positive contributions to the skills training for large student groups.
Bala et al. (2016)	To explore paramedic students' perception of the video-assisted learning method as an instructional method of learning emergency skills.	Qualitative research design The sample size included 20 paramedics (2 females and 18 males) age 21-23 years old divided into four groups	A semi-structured discussion guide was used to collect data on the participants' insight regarding the use of video for enhancement of knowledge	Thematic analysis	Participants said they were happy using the video and felt it increased their interest because they could view how the skill was done with a clearer picture in an easy-to-understand way. Participants felt that the video provided better	This study indicates that paramedics perceived video-assisted learning as a potential tool for learning emergency skills. It was suggested that the video instruction should be in the participants' native language for better understanding.

		Setting: Universiti Kebangsaan Malaysia Medical Centre Ethics approval was obtained prior to data collection.	and psychomotor skills. Data was collected through focus group discussion conducted after the training session.		understanding because they could see the steps one-by-one with an explanation which provided a better understanding. One participant noted that he concentrated his view and mind to the video because he was interested in the skill. Eight sub-themes were identified from the discussion: (i) increased their interest; (ii) provided better understanding; (iii) presented a better learning tool; (iv) increased their confidence; (v) promoted self-learning; (vi) enabled observation of learning by doing; (vii) helped them in learning procedure skills; and (viii) helped them in delivering standard information.	
Lee et al. (2016)	The purpose of this study was to identify the effects of a mobile-based video clip on learning motivation, competence, and class satisfaction in nursing students.	Randomized controlled trial with a pretest and posttest design. 71 nursing students participated in this study, 36 in the	Levels of learning motivation was measured by the Instructional Materials Motivation Survey (IMMS) developed by Keller	Descriptive statistics Pearson's correlation statistics Independent t test	The intervention group who received video education scored significantly higher in the areas of learning motivation, confidence in practice, and class satisfaction compared to the control group, but there were no	Video clips in nursing education help to promote nursing students' learning motivation and confidence in learning a clinical nursing skill; motivation and confidence in learning were improved, and students' satisfaction with the class was high. .

		interventio n group and 35 in the control group. Setting: A college of nursing in Seoul, South Korea Human subject issues include the inability to blind the students to the interventio n because this took place in an educational institution.	Class satisfaction measured using 0-10 self-reported Likert-type scale Knowledge level was measured using investigator-developed questionnair e with 10 multiple choice questions and five short answer questions .		statistically significant differences. There was a significant positive correlation for learning motivation with class satisfaction (r = 0.725, p < 0.001) and confidence in practice (r= 0.717, p < 0.001). There was a significant positive correlation between class satisfaction and confidence (r = 0.772, p <0.001).	
Mohd Saiboon et al. (2014)	To evaluate the effectiveness of self-instruction video in teaching other basic emergency skills in comparison with traditional face-to-face methods.	A single-blinded randomized control trial design. The sample size included forty-five participants who were first year undergradu ate medical students. Setting: Cyberjaya University College of Medical Sciences in Kuala Lumpur.	Psychomoto r skills were evaluated using the Objective Structured Clinical Examination (OSCE). There were two phases including the development of teaching materials and the evaluation of the new teaching methods. A five-point Likert scale was used to assess the confidence levels of	Descriptive statistics T test	The total mean score of most skill sets learned did not show any statistically significant difference between the two groups, face-to-face (6.85 +/- 1.21) and self-instruction video (6.20 +/- 1.04), p=0.54.	There was 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 and face-to-face instruction.

			students before and after learning particular skills.			
Chan (2010)	To determine and report the beliefs and use of video instructions as a tool for learning that transcends the classroom.	Qualitative Survey analysis design The sample included 31 student volunteer participants Setting: Multimedia University	A 5-point Likert-type scale was utilized to measure qualitative data on students' beliefs and preferences of video instructions for learning. (Scale based on 1-Absolutely No to 5-Absolutely Yes)	Qualitative data analysis Responses from Likert-type scale were analyzed, mean and standard deviations were calculated.	Feedback from the survey revealed that students believe that videos help them with their learning and are able to hold their attention. Video instructions are generally the most preferred method of learning as compared to other online learning media.	Video instructions are favorable to these university students and have a tremendous potential as a supporting tool for formal learning beyond the traditional classroom setting.
McCrossin, White, and Sane (2014)	To investigate the effect of high-fidelity simulation on the confidence and decision-making ability of anesthesia trainees in managing 'Can't Intubate, Can't Oxygenate' scenarios in subsequent simulation	Questionnaire, observational study design Sample size: nine anesthesia trainees from Logan Hospital Setting: Logan Hospital Ethics approval was obtained from the Metro South Human Research Ethics	A pre-study questionnaire was completed surveying confidence levels in anesthetic crises. Mini-simulation sessions were conducted and post-study questionnaires were completed (identical to the pre-study). Demographic data was collected, including years of anesthetic experience.	Descriptive statistics	There were differences in the median times for all timed goals between trainees who had undertaken the previous high-fidelity simulation and those who had not, these were in favor of simulation. The most significant difference was the 'time to LMA attempt' at 60 seconds for the simulation group compared to 115 seconds for the non-simulation group. Additionally, the 'time to percutaneous	This study suggests that high-fidelity simulation shortens the decision-making time of anesthesia trainees in subsequent 'Can't Intubate, Can't Oxygenate' scenarios.

		Committee in Brisbane, Australia. Written informed consent was obtained.	Times of the individual participants to achieve goals in the mini-simulation were recorded including: time to bag-mask, time to attempt a Laryngeal Mask Airway (LMA), time to call for help, time to perform a percutaneous airway, and number of deviations away from the Difficult Airway Society algorithm.		airway' at 111 seconds for the simulation group versus 172 seconds for the non-simulation group.	

Table 1: Demographics of Study Participants

Variable	Frequency	Percent
Gender		
Male	6	42.9
Female	8	57.1
Age		
20-25	1	7.1
26-30	8	57.1
31-35	5	35.7
Race		
White	10	71.4
Asian/Pacific Islander	4	28.6
Years ICU Experience		
2-3 Years	6	42.9
4-5 Years	4	28.6
>5 Years	4	28.6

Note. N = 14. All participants NAT-I.

Table 2: Pre-test Descriptive Statistics, Skewness, and Kurtosis

Descriptive Statistics and Skewness

	N	Mean		Std. Deviation	Skewness	
	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error
Prevention Score (out of 3)	14	1.79	.239	.893	-.278	.597
Recognition Score (out of 4)	14	1.07	.245	.917	.542	.597
Decision-Making Score (out of 4)	14	2.00	.331	1.240	-.282	.597
Prioritization score (out of 8)	14	2.50	.403	1.506	.709	.597
Total Score (out of 19)	14	7.36	.599	2.240	1.250	.597
Valid N (listwise)	14					

Kurtosis

	Kurtosis	
	Statistic	Std. Error
Prevention Score (out of 3)	-.327	1.154
Recognition Score (out of 4)	-.146	1.154
Decision-Making Score (out of 4)	-.945	1.154
Prioritization score (out of 8)	1.147	1.154
Total Score (out of 19)	1.865	1.154
Valid N (listwise)		

Table 3: Post-test Descriptive Statistics, Skewness, and Kurtosis

Descriptive Statistics and Skewness

	N	Mean		Std. Deviation	Skewness	
	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error
Prevention Score (out of 3)	14	2.79	.114	.426	-1.566	.597
Recognition Score (out of 4)	14	3.57	.137	.514	-.325	.597
Decision-Making Score (out of 4)	14	4.00	.000	.000	.	.
Prioritization score (out of 8)	14	6.79	.515	1.929	-1.523	.597
Total Score (out of 19)	14	17.14	.553	2.070	-1.253	.597
Valid N (listwise)	14					

Kurtosis

	Kurtosis	
	Statistic	Std. Error
Prevention Score (out of 3)	.501	1.154
Recognition Score (out of 4)	-2.241	1.154
Decision-Making Score (out of 4)	.	.
Prioritization score (out of 8)	1.601	1.154
Total Score (out of 19)	1.516	1.154
Valid N (listwise)		

Table 4: KR-20 of Knowledge Assessment Tool

Kuder-Richardson 20 PRE-TEST				
Case Processing Summary			**Reliability Statistics**	
	N	%	KR-20	N of Items
Valid	14	82.4	0.373	18
Excluded*	3	17.6		
Total	17	100.0		
* *Note. KR-20 not calculated for scales with items that had no variance.*				
Kuder-Richardson 20 POST-TEST				
Case Processing Summary			**Reliability Statistics**	
	N	%	KR-20	N of Items
Valid	14	82.4	0.678	13
Excluded*	3	17.6		
Total	17	100.0		
* *Note. KR-20 not calculated for scales with items that had no variance.*				

Table 5: Wilcoxon Signed Matched-Pairs Ranks Test

Descriptive Statistics					
	N	Mean	Std. Deviation	Minimum	Maximum
Mean Scores Pre-Test	14	7.36	2.240	5.00	13.00
Mean Scores Post-Test	14	17.14	2.070	12.0	19.00

Ranks				
		N	Mean Rank	Sum of Ranks
Mean Scores Post Test – Mean Scores Pre Test	Negative Ranks	0[a]	0.00	0.00
	Positive Ranks	14[b]	7.50	105.00
	Ties	0[c]		
	Total	14		

a. Mean Scores Post Test < Mean Scores Pre Test
b. Mean Scores Post Test > Mean Scores Pre Test
c. Mean Scores Post Test = Mean Scores Pre Test

Test Statistics[a]	
	Mean Scores Post Test – Mean Scores Pre Test
Z	-3.301[b]
Asymptotic Sig. (2-tailed)	0.001

a. Based on negative ranks
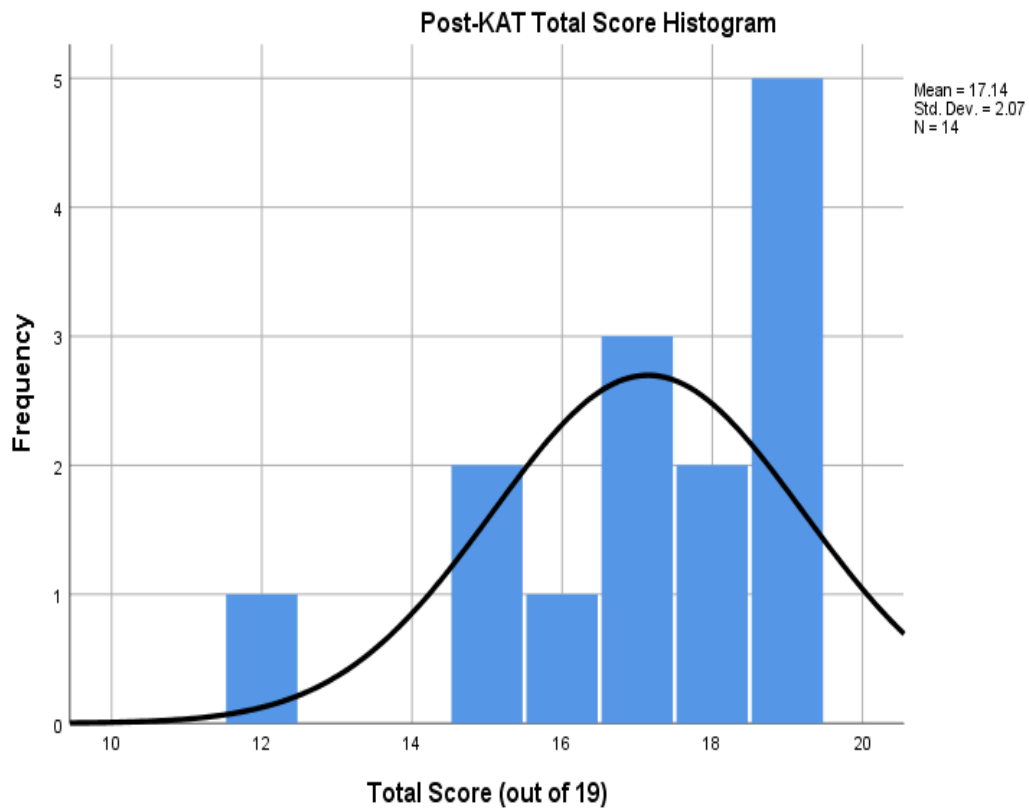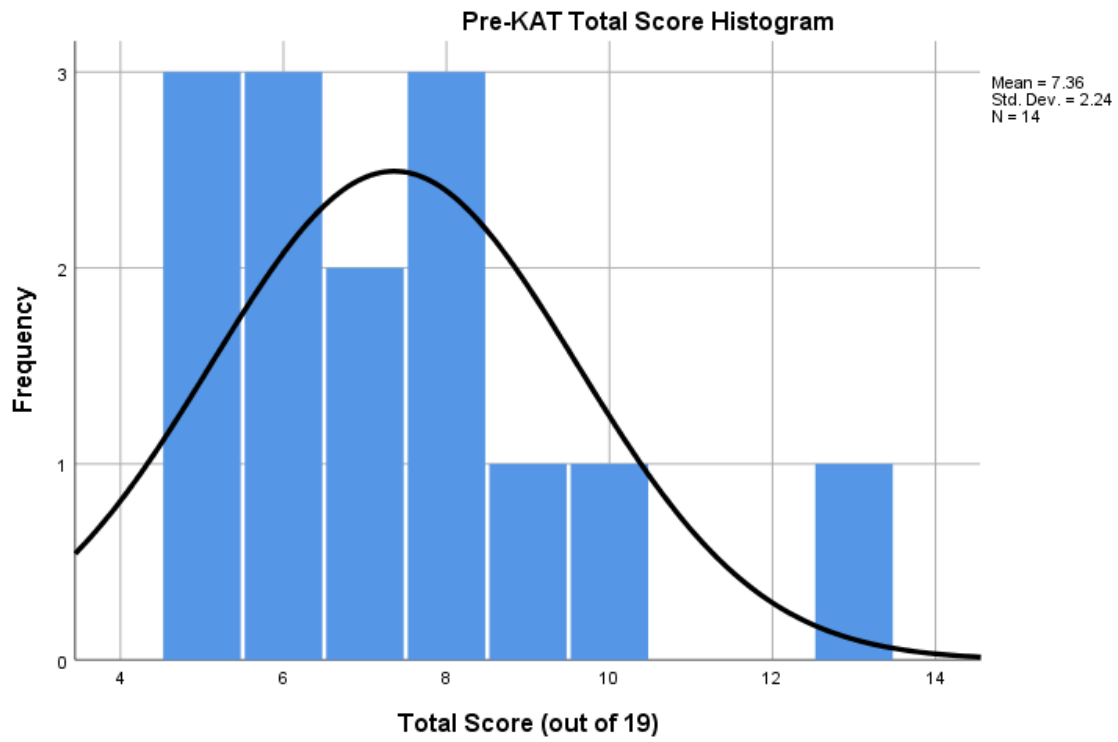b. Wilcoxon Signed Ranks Test

Figure 1: Histograms

Pre-KAT Total Score Histogram

Mean = 7.36
Std. Dev. = 2.24
N = 14

Post-KAT Total Score Histogram

Mean = 17.14
Std. Dev. = 2.07
N = 14

Figure 2: Pre/Post-Test Mean Score Bar Graph

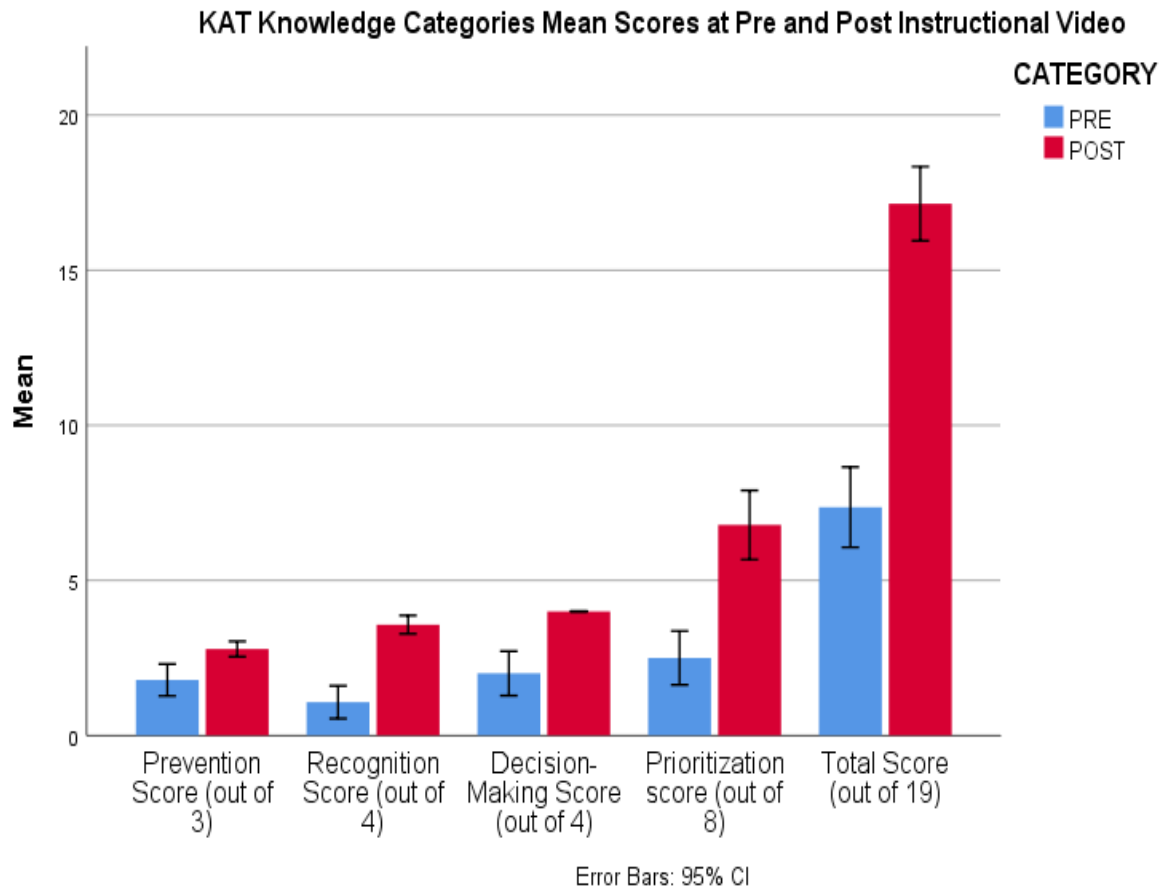KAT Knowledge Categories Mean Scores at Pre and Post Instructional Video

Error Bars: 95% CI

Figure 3: Pre/post-Test Confidence Bar Graph

Error bars: 95% CI