RUTGERS
School of Nursing

DOCTOR OF NURSING PRACTICE (DNP) PROGRAM

A DNP PROJECT

ANESTHESIA MACHINE FUNDAMENTALS: IMPROVING CLINICAL PERFORMANCE THROUGH ADJUNCT VIDEO REVIEW

STUDENT NAMES:
Anthony Rizzuti, BSN, RN, CCRN
Stacie Tittamin, BSN, RN, CCRN

DNP PROJECT CHAIR:
Maureen McCartney Anderson, DNP, CRNA/APN

DNP TEAM MEMBER(S):
Thomas Pallaria, DNP, CRNA/APN

DATE:
January 18th 2020

Anesthesia Machine Fundamentals:
Improving Clinical Performance Through Adjunct Video Review

Anthony Rizzuti and Stacie Tittamin

Rutgers School of Nursing

DNP Chair: Maureen McCartney Anderson, DNP, CRNA/APN

DNP Team Member: Thomas Pallaria, DNP, CRNA/APN

Table of Contents

Abstract

Nurse Anesthetists face a daunting educational curriculum from didactic to clinical practice requirements. Bridging didactic knowledge to clinical application is often a difficult task, and failure to do so adequately throughout one's career may result in adverse patient outcomes. A strong fundamental understanding of the anesthesia machine and the clinical application of that knowledge is critical to the delivery of safe confident anesthesia care and is one of the first goals in preparing for entry into practice. The purpose of this study was to ascertain if the creation and implementation of an anesthesia machine video adjunct review would improve knowledge and self confidence among Student Registered Nurse Anesthetists (SRNAs). A multicohort descriptive prospective design studied knowledge acquisition and retention as well as self-perceived confidence of 43 SRNAs enrolled in a single New Jersey institution. Pre- and post-tests and post- and delayed-post tests were employed to measure student confidence and knowledge after viewing a series of four adjunct videos related to the anesthesia machine. There was no statistical significance found in knowledge acquisition and retention. There was notable improvement in perceived confidence, with a pre-implementation confidence score averaging 2.5 out of 4.0 and a post-implementation confidence score averaging 2.95 out of 4.0. Based on the results, implementation of this video review adjunct was especially significant in improving confidence of junior SRNAs entering their first clinical rotation.

*Keywords**:*** anesthesia machine check, anesthesia education video, video adjunct learning, anesthesia machine failure, anesthesia video learning.

Introduction

Upon completion of any anesthesia program, the graduate anesthesia provider has an exceptional understanding of human anatomy, physiology, and pharmacology. Something that is easily overlooked is that these graduate students must also become engineering masters of the anesthesia machine. Student Registered Nurse Anesthetists (SRNAs) must learn how to quickly inspect, troubleshoot, and correct problems with this vital piece of equipment. Considering how highly conceptualized this topic is, there are limited credible resources that exist beyond the textbook to help the SRNA gain a strong foundational understanding and confidence in managing the anesthesia machine. A multitude of different anesthesia machines exist. Although they all follow the same fundamental principles of operation, anesthesia providers often have difficulty managing a model of anesthesia machine with which they are unfamiliar. Inadequate knowledge of the operation of these machines leads to patient safety risks including increased morbidity and mortality and makes for an incompetent provider. Inefficient operation/maintenance of these machines can lead to increased length of surgery due to anesthesia delays, wasted resources such as higher gas flow requirements due to leakage, and potential exposure of operating room personnel to unacceptable concentrations of waste anesthesia gasses.

To address this gap in knowledge acquisition, the authors developed of a series of evidence-based YouTube videos, approved and supported by the [redacted] Nurse Anesthesia Program (RNAP) and distributed to SRNAs to enhance their current textbook and simulation lab learning. The main goal of these videos was to provide SRNAs with a simplified understanding of the fundamentals by which all modern anesthesia machines operate. With the main goal established, the next step is to apply the fundamentals to a selection of the most common

machines used in clinical practice today. This approach was intended to allow SRNAs to more quickly and effectively apply advanced classroom and textbook knowledge, leading to improved confidence operating any anesthesia machine. We expected that this would translate to improved patient safety due to improved provider ability to identify machine faults prior to surgery (during machine-check) as well as better troubleshooting and recovery from potentially dangerous machine faults which may occur intraoperatively. In summary, predicted outcomes included improvements in knowledge acquisition and retention, overall self-efficacy and confidence, quality and safety of anesthesia care, and more efficient utilization of resources.

Background and Significance

To fully understand the importance and scope of the problem at hand, one must first appreciate the nuances, design, and operations of the anesthesia machine itself. The most basic functions of all anesthesia machines include the delivery of oxygen, vaporized anesthetic agents, and positive pressure-ventilation (Rose & McLarney, 2014). The many components of the anesthesia machine can be categorized into high, intermediate, and low-pressure subsystems, comprised of regulators, sensors, fail-safes, and valves that work in harmony to provide patients with safe and effective treatment (Ehrenfeld, Urman, & Segal, 2016). Although newer models feature a computerized interface that is able to perform an automated check, the ability to manually check the essential functions and safety devices within the machine is absolutely essential in order to troubleshoot and correct malfunctions that can occur at any time. Additionally, older models are still in use today and may be encountered by SRNAs and Certified Registered Nurse Anesthetists (CRNAs) alike. These older machines require manual checks in order to ensure proper functioning.

Modern anesthesia machines are extremely complex devices. This complexity provides for improved safety and functionality in order to prevent dangerous conditions, or when they occur, assist the anesthetist in identification and correction before patient injury occurs. The anesthesia provider must be able to understand, manipulate, and quickly troubleshoot these multifaceted systems in order to deliver a safe and efficient anesthetic. With improvements to modern equipment and training, there has been a significant decrease in patient injury over recent decades. Unfortunately, provider error and failure to perform an adequate machine check still contributes to instances of severe patient injury and death (Larson et al., 2007; Mehta, Eisenkraft, Posner, & Domino, 2013). Common errors leading to injury include misdiagnosis of and failure to adequately correct breathing circuit problems. According to a review of closed claims involving anesthesia gas delivery equipment from the 1970s to 2011, 85% of claims for injury/death involved provider error. Omitted or inadequate anesthesia machine checks contributed to 35% of the claims (Mehta et al., 2013).

In 1993, the Food and Drug Administration (FDA) released a document titled *Anesthesia Apparatus Checkout Recommendations*, which served as the first nationally published set of guidelines to encourage regular inspection of the anesthesia machine by the anesthesia provider prior to patient use. With equipment and technology evolving over the past few decades, the FDA recommendations have become outdated. In response to this, the American Association of Nurse Anesthetists (AANA), American Society of Anesthesiologists (ASA), and other members of the interdisciplinary anesthesia community came together in 2008 to release updated pre-anesthesia checkout guidelines which state that a single checkout procedure is no longer applicable to all anesthesia machines due to the significant differences among them (American Society of Anesthesiologists, Guideline for Designing Pre-Anesthesia Checkout Procedures,

2008). The guidelines state that despite the accepted need for a pre-anesthesia checkout, many providers do not adequately perform or understand the process. Additionally, the authors state that varying types of automated machine checks may not check all necessary functions. We propose that all of these concerns could be addressed upon by equipping providers with a better fundamental understanding of the functions of the anesthesia machine and potential modes of failure.

The anesthesia provider is ultimately responsible for the anesthesia machine checkout at the beginning of each day as well as an abbreviated check prior to each case. Specific policies vary among institutions. Many employ anesthesia technicians tasked with performing machine checks. Regardless, the anesthesia provider is ultimately responsible for their machine and must ensure that an adequate check has been performed prior to every anesthetic. SRNAs rotate through a multitude of clinical sites with varying equipment and policies. They often find themselves responsible for the safe operation of machines with which they are unfamiliar. For these reasons, it is imperative that we arm SRNAs with a foundational understanding that is more easily applied to varying clinical equipment, settings, and situations.

Needs Assessment

In the clinical experience of the authors, it has been observed that many anesthesia providers, regardless of experience level, perform a partial or inadequate machine check. According to the literature, this is responsible for over a third of serious injuries/deaths related to anesthesia delivery (Mehta et al., 2013). Additionally, we have observed machine faults which occurred after a thorough machine check. In one such case, the anesthesia technician replaced the CO2 absorbent canister but did not properly seat it, resulting in a leak and inability to ventilate the patient. The machine successfully passed a check prior to the case, before the absorber

change occurred. In this situation, the SRNA must rely upon their fundamental knowledge of anesthesia machine basics in order to quickly identify and correct the fault. Regardless of the type of anesthesia machine in use, the performance of a manual pressure-test by the anesthesia provider immediately prior to the start of the case would have quickly revealed a leak. Performing a pressure-test immediately prior to each use of the machine is recommended by numerous guidelines as well as by the manufacturers (American Society of Anesthesiologists, 2008)

The [redacted] University Nurse Anesthesia Program (RNAP) introduces SRNAs to the fundamentals of the anesthesia machine as part of a combination Physics, Technology, and Equipment in Anesthesia course. The learning process includes assigned readings, lectures, and a total of 4 hours in the simulation laboratory. The curriculum starts with the basics and then covers more advanced topics such as the mechanical workings of different types of ventilators. During the sim lab sessions, groups of 5-6 SRNAs obtain hands-on practice performing a manual machine checkout and simulating the clinical use of two different models of Drager Narkomed anesthesia machines. Knowledge and clinical competency are then assessed during a mock machine checkout at a clinical site utilizing more modern Drager Apollo machines which feature an automated “self-test” checkout. For most SRNAs, the day of their competency testing is the first time they are seeing this machine in person. [redacted] Nurse Anesthesia Program SRNAs are faced with the task of quickly adapting to new models of machines in many different rotations at differing clinical sites in New York and New Jersey. Many students express anxiety as well as a lack of confidence during their initial competency testing, as well as when starting new rotations due to unfamiliar equipment.

Knowledge related to the anesthesia machine is also tested professionally through the National Board of Certification and Recertification of Nurse Anesthetists (NBCRNA). Mandatory standardized exams sponsored by the NBCRNA include the Self-Evaluation Exam (SEE), taken by SRNAs to prepare them for the boards, and the National Certification Exam (NCE), the final exam graduate students must pass to enter nurse anesthesia practice. Sections of both of these exams are dedicated to equipment and technology, including complexities of the anesthesia machine. In addition to these exams, the NBCRNA has created core modules required for recertification that cover four major topics and are designed to keep nurse anesthetists up to date on evidenced based knowledge and practice. Anesthesia Equipment and Technology is included as one of these topics, supporting the importance of keeping up to date in this area of practice.

Newer generations of learners are increasingly seeking alternative sources of knowledge beyond the classroom and textbooks in order to gain new knowledge. They are more likely to turn to the internet and social media for knowledge acquisition and verification of clinical practices (Carroll, Bruno, & vonTschudi, 2016). Due to its ubiquitous nature, many students turn to YouTube in order to search for simplified videos showing functionality and checkout process of different models of machines. These videos often fail to explain the rationale behind the steps involved, are not evidence-based, or make erroneous statements. This often leads to further anxiety and confusion among new SRNAs. The utilization of videos to acquire clinical knowledge has been shown to be preferred by many students and advantageous over traditional didactic lectures (Grosser, Bientzle, Shiozawa, Hirt, & Kimmerle, 2018). There is evidence to support better knowledge retention and improved scores on standardized exams when utilizing the flipped-classroom approach in medical education (Gillispie, 2016).

The need for a credible evidence-based video review is supported by the challenges faced by SRNAs as well as the potential benefits offered by utilizing modern electronic learning adjuncts. Incidentally, a previous RNAP DNP project established a YouTube channel, *Total Recall*, in which all content that is uploaded has met standards and criteria set forth by both the RNAP as well as the American Association of Nurse Anesthetists (AANA), thus promoting a credible platform and vetted resource for students to access. Previously missing from this channel were any videos addressing the anesthesia machine. The [redacted] Nurse Anesthesia Program has numerous clinical affiliations which provided us with access to a wide variety of anesthesia machine models to be used in the creation of the video series. In addition, these videos are intended to provide a useful review for practicing CRNAs in order to improve their knowledge, skills, and confidence and perhaps assist them in completing recertification requirements.

Problem Statement

Despite textbook explanations and in-class lectures, novice SRNAs in their first semester of clinical training lack the experience and hands-on training required to confidently execute a basic anesthesia machine checkout and troubleshoot faults. Thus, they stand to benefit from alternative methods of learning. Senior SRNAs also stand to improve their knowledge retention and troubleshooting skills by utilizing a video adjunct for review.

Our PICO(T) question was: Does the implementation of a video learning adjunct on applying the fundamentals of the anesthesia machine to clinical practice (I) improve the confidence and clinical performance (C) of SRNAs (P) during their nurse anesthesia residency (T) resulting in improved anesthesia quality and safety(O)?

Aims and Objectives

The overall aim of this project was to demonstrate improvements in SRNA knowledge and confidence in the checkout, operation, and troubleshooting of the anesthesia machine. This aim was accomplished through the creation and implementation of supplemental video resources including case scenarios. Objectives included:

1. Creation and implementation of a series of 6 short YouTube videos focusing on anesthesia machine fundamentals and the clinical application of those fundamentals to common anesthesia machine models in order to improve the SRNAs ability to quickly and safely adapt to new equipment. The videos were broken down into the following topics:
    a. Anesthesia machine fundamentals
    b. Anesthesia machine checkout
    c. Drager Anesthesia machine check (Apollo and Perseus)
    d. GE Anesthesia machine check (Avance and Aestiva 5)
    e. Anesthesia machine operative scenarios for identifying and correcting common machine failures
2. Evaluation of SRNAs knowledge acquisition and retention regarding fundamentals, machine checkout, and machine failure scenarios, how to identify them, and how to respond to them based on immediate post-implementation and delayed post-implementation test scores.
3. Evaluation of the effect of these videos on SRNA-perceived confidence by utilizing a pre- and post-implementation survey. In addition to general confidence related to troubleshooting the anesthesia machine, questions also evaluated perceptions of:

a. Readiness to operate the anesthesia machine upon entry into clinical (D4 cohort)

b. Confidence in achieving a successful score on the equipment, instrumentation, and technology portion of the Self-Evaluation Exam (SEE) and/or the National Certification Exam (NCE) (D3/D4 cohorts).

Review of Literature

Articles reviewed were obtained by utilizing the Rutgers University Library Health Sciences search engine which encompasses numerous databases, including EBSCOhost, CINAHL, Google Scholar, ClinicalKey, the Cochrane Library, Ovid Journals, PubMed, and Wiley Online Library. Combinations of search terms used include: “social media”, “video-based learning”, “YouTube”, “millennial learners”, “nurse anesthesia”, “anesthesia education”, “medical education”, “anesthesia machine check”, “anesthesia machine failure, “anesthesia machine fault” “anesthesia equipment” “anesthesia clinical performance”, and “anesthesia teaching methods clinical performance”. Articles were filtered to fit the following criteria: peer-reviewed, available in the English language, and published within the past 5 years. Some articles greater than 5 years old were included as they were determined to be of critical importance for this literature review. A PRISMA flow diagram was utilized to record the literature identification, screening, and eligibility process (Appendix A). A Table of Evidence was then constructed to summarize these articles (Appendix B).

Anesthesia Machine Equipment Failure and Safety

Anesthesia quality and safety depends upon many variables. Safe and efficient use of equipment is paramount among them. Cooper, Newbower, and Kitz (1984) analyzed 1089 preventable critical anesthesia incidents among 139 providers at 4 Boston hospitals. They

identified human error as the cause in the vast majority of the incidents with only 4% being attributed to equipment error. The authors concluded that the most common causative factor was unfamiliarity with equipment “associated with use of a relatively new technique or device”. This landmark study supports the need to improve the anesthesia providers ability to quickly adapt to and familiarize themselves with new equipment in order to improve patient safety. Even experienced anesthesia providers are susceptible to operator error. Larson et al. (2007) found that providers with more than 7 years of experience had the highest rate of failure to detect faults during machine-checkout. Fasting and Gisvold (2002) found that 33% of anesthetic equipment problems involved the anesthesia machine; 25% of those problems involved human error with the majority attributed to inadequate checkout procedure.

Without a strong fundamental knowledge-base, providers are less likely to identify and appropriately respond to the root cause when an anesthesia machine failure occurs. Shahriari, Khooshideh, and Sheikh (2016) report on an incident in which a patient suffered a pneumothorax after induction of anesthesia due to a circuit misconnection leading to elevated airway pressures. The provider failed to identify the fault during the checkout procedure. Moreno-Duarte, Montenegro, and Schumann (2017) report an incident in which failure to ventilate occurred after induction. Providers responded by switching to total intravenous anesthesia and ventilating with a bag-valve mask. The cause was later identified to be a faulty CO2 absorbent canister. An automated anesthesia machine check was performed but failed to identify the fault.

Teaching the Millennial Learner

The majority of today’s student population is comprised of the millennial generation, learners born in early 1980’s through the mid 1990’s, characterized by techy-savvy users that are accustomed to immediate on-demand access to information and communication (Zoghbi et al.,

2018; Johnston, Barton, Williams-Pritchard, & Todorovic, 2018). This generation is unique in that they have grown up around the Internet and ever evolving technologies and are thus adept at employing them in everyday personal and professional life (Zoghbi et al., 2018; Hopkins et al., 2018; Bergl & Muntz, 2016). When evaluating their preferred method of learning, an editorial by Hopkins et al. (2018) found a propensity towards convenient, easily accessible and technologically enhanced educational material, such as podcasts, interactive multimedia tutorials and other methods of E-learning. Millennials are comfortable and competent in navigating technology and social media; it is only reasonable to infer that expanding traditional education to include avenues of technology and social media will enhance their learning experience (Hopkins, et al., 2018; Sterling, Leung, Wright, & Bishop, 2017).

Evaluation of Social Media in Education

Roland and Brazil (2016) describe social media as "an openly accessible participation and engagement platform;" this platform includes a variety of mediums such as YouTube, Facebook, Twitter, and audio podcasts. An overarching disparity identified by systematic reviews of social media in medical education is the lack of high-quality research on direct outcomes, potentially due to the fact that many of these platforms are unregulated and unsupervised (Sutherland & Jalali, 2017; Sterling et al., 2017). Other potential challenges of social media may include technical difficulties and varied levels of participation, especially when addressing learners and educators preceding the Millennial generation (Cheston, Flickinger, & Chisolm, 2013).

Despite the variable quality of material found on social media, higher learner satisfaction and positive qualitative feedback have been noted as a result of integrating social media with traditional lecture-only teaching methods (Moghavvemi, Sulaiman, Jaafar, & Kasem, 2018;

Cheston et al. 2013). Sterling et al., (2017) found that social media platforms effectively served as a means to promote clinical concepts, circulate evidence-based material to a larger audience, reinforce technical skills, and encourage self-efficacy. According to Cheston et al. (2013), favorable attitudes towards social media led to the belief that its role in medical education can positively impact learner outcomes.

A 2018 editorial by Nettle highlights advantages of combining social media with medical education. For example, social media publications can be reviewed and criticized by experts in the field in real-time and allow for continuous feedback and dialogue; traditional peer-reviewed publications lack this flexibility and user interaction. It is postulated that crowd-sourced reviews backed by appraisal tools may be used to validate social media for medical education in the future.

YouTube as a Learning Tool

Identified as one of the top websites in the world based on traffic ranking, YouTube is a unique video-based social media platform in which user interaction and "the formation of social relationships... revolves around uploaded videos" (Moghavvemi et al., 2018). While notable for its entertainment value, YouTube has also emerged as a popular learning tool. With universities creating their own channels, videos are curated and uploaded in order to complement classroom education, such as those found within the RNAP channel, Total Recall: Educational Videos for SRNAs. Results of data collected by Moghavvemi and colleagues (2018) showed that students choose to turn to YouTube to learn about current courses, to learn how to solve problems, to answer specific questions, and to attain new knowledge in general.

As previously discussed, due to high variability of content, it is difficult to claim any outlet of social media as a suitable educational resource. In Sutherland and Jalali's literature

review on social media (2017), four studies were discussed that concentrated on quality of YouTube videos and their place in medical education. Unless backed by reputable sources or academic institutions, it is difficult to determine educational value of uploaded videos; the authors generalized that YouTube was an inadequate source for educational purposes until a moderating service could be instituted to assess the quality of these educational videos.

A quasi-experimental study by Johnston et al. (2018) aimed to look at the utilization and potential effect of a series of YouTube videos created by bioscience staff, geared towards nursing and paramedicine students. The investigators discovered that a relatively small investment of time on behalf of the academic staff to create videos led to a large volume of student learning time, as evidenced by the over 1.5 million minutes of viewing time accumulated over a two-year period. These educational videos allowed for round-the-clock, self-directed learning and were met with overwhelmingly positive student feedback. Additionally, none of the student responses indicated that the videos required additional time and/or effort compared to alternative methods of learning the course content. The students reported increased motivation as well as better accessibility and reusability of the content in video form. We expect this to translate to improvements in motivation, accessibility, and reusability within the SRNA community due to the nature of SRNA educational requirements and practice settings. For example, an SRNA may elect to view a short YouTube video on their mobile device in order to familiarize themselves with a new anesthesia machine on the first day of a rotation at a new clinical site or at any point in time in which they are performing a machine checkout on a unfamiliar machine.

Effectiveness of Video-Based Learning

Numerous studies were reviewed that examined the effects of video-based learning and simulation. Kelly and colleagues performed a quasi-experimental multi-method study to assess the effectiveness of online instructional videos and students' attitudes towards them (2009). A control group of learners were taught a clinical skill in the traditional manner of lecture and supervised practice. In comparison, the experimental group of learners received instructional videos and supervised practice. No statistically significant differences were appreciated in measured clinical skill scores. While the data does not support substituting in-person lecture with instructional videos, the results of an attitude questionnaire completed after the last day of the study found that the majority of students supported the use of videos as an adjunct to traditional teaching. In fact, students requested additional online videos be made available to review for future classes. Chi, Pickrell, & Riedy (2014) explored dental student-reported outcome measures comparing video versus paper presentation of simulated case studies. The video case studies were rated as a more effective format and were associated with higher scores in outcome measures such as knowledge attainment and critical thinking ability. Students preferred the video formatting as it made the scenarios feel more realistic and relatable.

Incorporation of video vignettes is also supported by McLain, Biddle, and Cotter's 2012 study of SRNAs in the simulation lab. This study is of particular importance because it explores the outcomes of video learning on SRNA clinical performance and information recall of patient safety case scenarios focused on anesthesia equipment malfunction. Unfortunately, while it provides randomized controlled level I evidence, the results are poorly generalizable due to small sample size and failure to utilize a standardized and proven data collection tool. The authors recommend further study, which this project seeks to accomplish.

Zoghbi et al. (2018) took a small sample size of 11 general surgery interns and exposed them to 2-3-minute-long “how to” videos. They hypothesized that these videos would “enhance clinical performance” and “improve [interns’] efficiency, confidence, and task completion rate.” Though limited by such a small sample size, this study did find significant improvements in amount of time required to complete tasks, self-reported confidence to complete 5 of the 7 tasks, and clinical scores during emergency simulations. This supports the hypothesis that our video implementation will improve adherence to the anesthesia machine check, shorten the time spent on it, and improve anesthetist confidence and responsiveness to machine failure.

Lastly, a prospective interventional study performed by Kandler et al. (2016) assessed the impact of an educational video on Rapid Sequence Induction (RSI) protocols. Observers compared anesthesia providers’ propensity to adhere to a 14-point RSI protocol before and after video implementation. Post-video adherence was significantly improved in 8 of the 14 measurable points. Adherence to the steps of the anesthesia machine checkout protocol may be improved in a similar way.

In summary, utilization of social media such as YouTube has been identified as a potential learning tool to stimulate and motivate the Millennial learner. Care must be taken to assure educational resources created and disclosed in the realm of social media be supported by academic institutions and evidence-based research. Researchers as well as students have reported positive feedback regarding the implementation of video-based learning supplements, but the majority of existing studies are poorly generalizable and/or lack a focus on the combination of anesthesia providers, video adjuncts to learning, and measurement of improvements to knowledge and confidence. Combining a video-based educational tool with traditional classroom

learning has the potential to enhance acquisition of new skills, reduce time to complete tasks, increase self-reported confidence, and improve clinical performance.

Theoretical Framework

John Keller's ARCS Model of motivational design was selected and adapted as the framework for this project (Appendix C). It is a motivation-based instructional design model, built upon the expectancy-value theory (Keller, 1987). This theory posits that a combination of the potential value and expected success attributed to a particular choice is what drives certain behaviors or actions. From this theory, Keller defined four main conditions that must be continuously addressed when creating an instructional design in order to capture and maintain motivation: *Attention*, *Relevance*, *Confidence*, and *Satisfaction* (Keller, 2010).

Attention of the learners is needed to gain and maintain a level of interest in the lesson at hand (Keller, 2010). Strategies outlined to garner attention include perceptual arousal, inquiry arousal, and variability. These strategies ensure that curiosity is maintained and boredom is avoided. By providing a video adjunct, learners will have an increased perceptual arousal and inquiry compared to traditional learning methods, as supported by the literature. The video adjunct also provides variability allowing for better knowledge reinforcement and improved ability to meet different individual learning styles.

Relevance is defined as finding a way to connect the lesson with value, and may be addressed by entwining goal orientation, motive matching, and familiarity into lesson plans. We accomplished this by reviewing the risks that exist if the anesthesia machine is not properly checked or if it malfunctions and the anesthetist is unable to detect and adequately respond to correct the malfunction. Goal orientation encompasses the need to practice safely. These items were addressed in both our recruitment material as well as within the videos themselves.

Confidence requires a balancing act on the educators' part; students must feel they have the ability to succeed without allowing them to be overly self-assured. Confidence may be built by outlining learning requirements, incorporating success opportunities that will boost learners' beliefs in their competence, and allowing them to feel a level of personal control over their success. Implementation of the adjunct video review addresses this by assisting in meeting learning requirements more quickly and efficiently through improved foundational knowledge acquisition. Success opportunities were offered in the machine failure simulation video by giving participants the opportunity to identify the failures before the answers are revealed.

Finally, a sense of *satisfaction* must be achieved in order to reinforce value in the learning process. Strategies to promote satisfaction may include praise to enhance intrinsic motivation, positive consequences in the form of awards, or special privileges to promote extrinsic motivation and assure equity. Intrinsic reinforcement was achieved by providing a sense of achievement through knowledge enhancement with a minimal time investment through a familiar and engaging medium. Extrinsic reward occurred when the SRNA applied this new knowledge in the clinical setting and experiences improved performance and confidence. Equity is addressed by the nature of the medium. It is available to all students on-demand with no cost and can be reviewed at any time and in any setting based on learning preference.

With these four pillars of the ARCS model in mind, achievement of motivation is also described in a ten-step systematic motivation design process that is broken down into four phases: Define, Design, Develop, and Pilot. Key elements of the defining phase include gathering information related to instructional goals, analyzing the intended audience, analyzing existing educational and motivational materials, and articulating motivational objectives. Instructional goals are clear based on the existing curriculum within RNAP and were adhered to

within the videos. The intended audience sought alternatives to traditional learning based on the literature and the use of the YouTube platform addressed this point.

The designing and development phases are more creative in nature. Design involves brainstorming potential strategies and determining which direction to go and should follow certain guidelines: “(a) not take up too much instructional time, (b) not detract from the instructional objectives, (c) fall within the time and money constraints of the development and implementation aspects of the instruction, (d) be acceptable to the audience, and (e) be compatible with the delivery system” (Keller, 1987, p. 7). All of these guidelines are easily achieved by this medium as it requires minimal time, enhances the instructional objectives, has no cost, is sought after by the intended audience, and is easily delivered by the devices which are already a requirement to enter RNAP (a mobile computer).

Development involves the creation of new motivating materials, in this case educational videos, and their integration into classroom instruction (Kelly, 2010). Our development phase occurred prior to the junior class of SRNAs, referred to as the D4 cohort, beginning their first clinical rotation, during the summer of 2019. The evaluation phase consisted of pre- and post-implementation surveys to assess self-confidence as well as post-intervention assessment of learning outcomes and knowledge retention as measured by a knowledge assessment survey. Future analysis of SEE and NCE scores within the equipment and technology category will be addressed once updated data becomes available.

Methodology

This study utilizes a multicohort descriptive prospective design. Students from multiple nurse anesthesia cohorts were asked to attend short presentations in order to view our anesthesia machine videos. They were then provided with links so that the videos could be accessed at any

time. Self-confidence was measured in both cohorts (D3 and D4) by utilizing pre- and post-intervention surveys in order to identify changes to perceived confidence immediately before and after viewing the videos. Post-intervention knowledge and retention were measured based on the percentage of correct responses to a short quiz completed immediately after viewing the presentation and again approximately three months later at the start of the Fall 2019 semester.

Setting

The presentations took place at [redacted] campus in the [redacted] building. The video review and data collection were held in a classroom equipped with adequate seating and a projector screen for group viewing. The study took place on a didactic day during which RNAP students from both cohorts were already in the building for scheduled class time. The total time required in the classroom for each of the two presentations was approximately 25 minutes.

Study Population

The study population includes members of the RNAP D3 and D4 cohorts (N=43 participants). At the time of implementation, the D4 cohort (junior SRNAs) were preparing to enter their first part-time nurse anesthesia residency rotation, with no prior hands-on anesthesia clinical experience. The D3 cohort (senior SRNAs) were participating in full-time clinical rotations and preparing to take the NBCRNA Self Evaluation Examination (SEE) for the first time. Results varied among the cohorts, likely due to the lack of clinical experience in the D4 cohort as well as their much more recent didactic experience compared to the D3 cohort. Exclusion criteria included any student not enrolled in the RNAP at the time of implementation.

Subject Recruitment

Subjects within RNAP were recruited by means of a flyer (Appendix D) posted within the [redacted] School of Nursing, email, and announcements made at a monthly RNAP departmental program meeting. The recruitment email was sent to the D3 and D4 cohorts by the RNAP program assistant and included a copy of the approved flyer as well as the date, time, and classroom location for both the D3 and D4 implementation sessions.

Consent Procedure

Participant consent was implied; it was discussed with subjects upon arrival to the classroom, prior to the presentations. All study participants were notified that participation is entirely voluntary and that those who do not participate may still access the videos supplied to the study participants, should they so choose. Subjects were informed of the purpose of the study and advised that by completing any of the surveys, they are implying consent. Participants were free to drop out of this study at any time. The informed consent can be seen in Appendix E.

Risks/Harms

No potential risks, harms, or ethical concerns to participants were identified in this study. Privacy and confidentiality of data were maintained at all times. All collected data and surveys contained no identifying information. Collected data was secured at all times.

Subject Costs and Compensation

There were no costs to subjects participating in this study, therefore there was no compensation offered.

Study Interventions

The study intervention includes an explanation of the purpose of the study, followed by a screening of six short videos on the subject of anesthesia machine fundamentals, check-out, and

troubleshooting. The first video focuses on fundamentals of the general anesthesia machine check-out. The subsequent four videos demonstrate the application of these principles to four of the most commonly encountered anesthesia machines: Draeger Apollo, Draeger Perseus, GE Avance/Aespire, & GE Aestiva 5. The final video includes case scenarios in which common machine failures occur in a simulated operating room setting. A letter of cooperation was obtained in order to film the necessary content (Appendix F) at two affiliated clinical sites. After the implementation sessions were completed, all videos were made available to view on the official RNAP YouTube channel, *Total Recall: Educational Videos for SRNAs*.

Outcomes Measured

Pre- and post-intervention surveys were utilized at the presentation, accessible through an online service, Qualtrics. Prior to the start of the presentation, participants were asked to complete a survey designed to measure perceived confidence in anesthesia machine knowledge and application (Appendix G). This survey has been adapted from the General Self-Efficacy Scale (GSE) (Schwarzer & Jerusalem, 1995) which has strong consistency and has been well validated in 31 countries/languages (Kusurkar, 2013). Permission was obtained to use and modify this scale (Appendix H). Post-intervention, this survey was repeated in order to measure changes resulting from the presentation. Likert-scale ratings were utilized to assess confidence as well as participants likelihood of utilizing these videos again for review when encountering unfamiliar anesthesia machines at different clinical sites. The Knowledge Assessment Survey (Appendix I) is a multiple-choice knowledge survey that was taken immediately after viewing the presentation with the intent to examine subjects' ability to correctly identify and troubleshoot common anesthesia machine problems. In order to measure knowledge retention, subjects were asked to repeat the knowledge survey approximately three months later at the start of the Fall

2019 semester. Questions comprising this survey were created based upon a review of literature pertaining to the anesthesia machine and have been vetted by three experienced nurse anesthesia faculty members.

Project Timeline

The project timeline (Appendix J) includes initial planning, development of videos, implementation, data collection, data analysis, and dissemination of results. The timeline spans a period of approximately ten months. Project planning took place through the month of April 2019 and concluded after the final proposal presentation and poster session on April 29th, 2019 and April 30th, 2019. Upon approval of the proposal, documentation was submitted for IRB approval with revisions made as necessary. The IRB approval process spanned approximately 1 month. After gaining IRB approval, the previously scripted videos were filmed, edited, and implemented to both cohorts during the 2019 summer semester. The D4 implementation occurred during the Intro to Anesthetic Equipment course, immediately prior to the cohort beginning their first clinical rotations. Implementation for the D3 cohort occurred as part of the Quality, Safety, and Access in Anesthesia course. Data collection occurred immediately before and after subjects viewed the videos. The knowledge survey was repeated during the first week of September 2019. Data analysis occurred throughout July and the beginning of September; evaluation and synthesis of the results took place through October. At the state level, results were presented during the New Jersey Association of Nurse Anesthetists (NJANA) Fall 2019 Conference on October 5th, 2019.

Resources

Minimal financial resources were required to complete this study. The required professional video recording equipment and editing software was already available to the

investigators. Key clinical sites were identified where videos were recorded, with permission, and at no financial cost. A clinical site agreement is in place with all facilities in which recordings took place. Clinical sites were de-identified within all recorded videos. Pre- and post-intervention survey/tests were completed utilizing Qualtrics, a statistical analysis software program provided at no cost by the University.

Evaluation Plan

Data Maintenance and Security

All data was obtained, stored, and aggregated in an encrypted and password protected state utilizing the Qualtrics service; it was solely accessible to the principal investigators and DNP Chair, Dr. Maureen McCartney Anderson. Surveys and tests were completed anonymously. No personal health identifiers were collected and IP addresses of participants were not collected, therefore confidentiality was maintained with no destruction of data required.

Data Analysis and Results

Data collection and subsequent analysis was performed utilizing Qualtrics software as well as IBM SPSS Statistics 23. Descriptive statistics, specifically mean, median, and mode, were used to evaluate central tendency data trends. Based on the abnormal distribution of both confidence and knowledge assessment survey results (abnormal Q-Q plots and Shapiro-Wilk Sigs) as well as the small sample size, the Wilcoxon Signed-Ranks test was selected to compare pre and post intervention perceived confidence survey results (Appendix K). This resulted in significant findings which we discuss shortly. It was also selected in order to compare the post and delayed post intervention knowledge assessment surveys. The results for the knowledge assessment surveys were inconclusive.

A Wilcoxon Signed-Ranks test indicated that the post-intervention perceived confidence scores (mean rank = 17.7) were significantly higher than pre-intervention confidence scores (mean rank = 8.0), Z = -4.3, p = 0.000. This test is inclusive of data from all participants (both the D3 and D4 cohorts). This test was then repeated in order to compare pre and post intervention results for each cohort independently. Results indicated that among the junior (D4) cohort the post-intervention perceived confidence scores (mean rank = 10.4) were significantly higher than pre-intervention confidence scores (mean rank = 3.0), Z = -3.7, p = 0.000. Among the senior (D3) cohort, the post-intervention perceived confidence scores (mean rank = 7.6) were not significantly higher than pre-intervention confidence scores (mean rank = 7.2), Z = -1.9, p = 0.051. The p value is outside of the 95% confidence interval; therefore, this result is not significant.

Confidence scores ranged from 1 to 4, following the adapted General Self Efficacy scale. The overall pre-intervention mean confidence score was 2.46; post implementation it rose to 2.95 (N = 37). Breaking the scores down by cohort, the junior cohort score rose from 2.09 to 2.75 while the senior cohort confidence score rose from 2.82 to 3.14. The senior SRNAs had higher overall confidence scores both pre and post intervention. The junior SRNAs had lower confidence prior to the intervention but demonstrated a significant increase in post-intervention confidence scores.

The results of the knowledge assessment surveys were inconclusive. A Wilcoxon Signed-Ranks test indicated that there was no significant difference between post implementation and delayed post implementation knowledge surveys (respectively, mean ranks were 16.5 and 17.6), Z = -.3, p = 0.781. The p value is outside of the 95% confidence interval; therefore, this result is not significant. The mean post-intervention survey score was 63%. The mean delayed post-

intervention survey score was 64%. These scores are inclusive of both cohorts. Breaking the scores down by cohort introduces a number of confounding variables and did not result in significant findings.

Discussion

A major theme during the literature review phase of this study was the willingness of students to utilize video adjuncts in order to support their overall learning. The final question in our confidence survey asked participants if they would refer to the videos in the future. Based on the overall response of 3.64 out of 4, the majority of participants agreed that they would do so. Study participants told us that they found the videos extremely helpful and many did report utilizing them independently after the initial implementation was completed. Regardless of initial confidence scores, students from both cohorts reported increased confidence after the video implementation. Clinical preceptors reported that junior SRNAs appeared to be more knowledgeable and comfortable with the anesthesia machine after implementation to their cohort.

YouTube is a useful platform for video-learning when utilized effectively, but there are many other options available which may warrant further exploration. Increased accessibility of information means students are more likely to look back at this info for a quick review when unsure of an issue, but this does not eliminate the need for didactic teaching along with this resource as evidenced by the poor knowledge assessment scores.

Key facilitators for this project included the video recording/editing equipment which was readily available to the authors. Additionally, letters of cooperation with clinical sites allowed easy access for filming. Significant barriers to the project included distractions during in-person video implementation, likely because it was done during long didactic days. It is

difficult to determine the amount of attention that participants gave to the video presentations. Perhaps participants would have demonstrated better knowledge acquisition if they had viewed the videos and completed the surveys at home at their leisure.

Our post and delayed-post knowledge assessment results were inconclusive due to a combination of likely factors. Primarily, we do not have a baseline to compare to. If this study were repeated among future cohorts, trends in the data might be established from year-to-year changes with and without our intervention. The content of the survey questions may also be responsible for the confusing results. Perhaps a better system should have been utilized to vet the questions for accuracy and level of difficulty. Confounders among the two cohorts makes comparison of results between them very difficult. The D4 cohort starting clinical prior to our delayed-post survey means that they were exposed to habits of seasoned practitioners which may not coincide with the textbook and may have altered their question responses. The D3 cohort was preparing for standardized exams, so improvements to scores was likely a result of this. The videos were not uploaded to the SRNA YouTube channel as early as we intended. Because of this, a temporary link was provided prior to YouTube availability of the videos. This resulted in an inability to accurately track the view count for each video. One unintended consequence was that the knowledge assessment scores may have highlighted an area of weakness in SRNA learning; or, may have been because we pick up bad habits in clinical, meaning not just students need a refresher – this may be applicable to seasoned CRNAs as well. A future study including practicing CRNAs in the knowledge assessment survey may provide insight into the different knowledge gaps that exist among SRNAs versus CRNAs.

Implications & Recommendations

The results of the knowledge assessment have opened our eyes to potential areas of improvement as discussed. While introducing the anesthesia machine fundamentals is important to new SRNAs prior to entering clinical, we clearly need follow up lessons and refreshers for senior students. We believe it is important to start a discussion after students have settled into their clinical rotations. Do they remember what parts of the machine check are mandatory on a daily basis versus prior to each case? And what do they actually see and practice at each clinical site compared to textbook teachings? Revisiting these topics will also help prepare students for board examinations such as the SEE and NCE. Perhaps future studies could better explore the effects in this area. There is also the potential for clinical facilities and anesthesia groups to use these videos as a tool for training anesthesia staff to their specific equipment. Despite the RNAP YouTube channel having roughly 300 subscribers, within three months of being uploaded these videos accumulated over 1,200 views, giving further proof to their applicability and accessibility. They could be useful to anesthesia techs, anesthesiologist assistants, and anesthesiologists.

Economic Costs and Benefits

The economic cost of the project was negligible as the necessary materials were already available to the investigators. There was no cost to any individual participant or institution involved in the study. Multiple study participants (SRNAs) as well as clinical instructors (CRNAs) reported beneficial outcomes as a result of implementation. The RNAP sponsored YouTube channel, *Total Recall,* provides a free platform to upload and view credible content that has met designated standards set forth by the channel's creators in conjunction with the AANA, and will continue to be openly available for all members of the nurse anesthesia community and population at large. Potential outcomes of the anesthesia community accessing these videos

include more efficient use of anesthesia consumables such as circuits, absorbers, and machine parts due to more efficient troubleshooting and failure identification. For example, we anticipate that an SRNA may identify the source of a leak more quickly following implementation. By doing so, they are more likely to avoid the unnecessary replacement of parts that are not actually contributing to the problem.

Impact on Healthcare Quality and Safety

By improving SRNA clinical knowledge and confidence, we anticipate that the quality and safety of their clinical practice will be improved over time. For example, SRNAs will be better prepared to identify and correct machine failures that could occur during a case. The performance of an adequate machine check as well as the ability to properly diagnose and correct these problems is likely to result in a reduction in adverse outcomes as evidenced by closed claims studies (Larson et al., 2007; Mehta et al., 2013).

Policy Implications

Based on our finding of improved perceived confidence, inclusion of these video adjuncts will have a positive impact on the future education of nurse anesthetists. The videos have been integrated into the future curriculum as an adjunct to the existing educational materials. Future research could explore the impact of additional video adjuncts on SRNA education and clinical practice. In particular, this research could be expanded to include educational adjuncts for the improvement of CRNA clinical practice through continuing education outside of the classroom. We hope future study will demonstrate improved outcomes on SEE and NCE scores. Additionally, the NBCRNA has put forth the requirement to complete 4 Core Modules during every 4-year cycle of practicing anesthesia with the intention of keeping practitioners up to date on current literature and evidenced based practice. One of the 4 core modules is Anesthesia

Equipment and Technology. This video review may be used to assist an organization in developing a continuing education program that focuses on this topic to help keep their members compliant with NBCRNA standards.

Sustainability & Translation

Sustainability is easily achieved by a project of this nature as there are numerous avenues to be explored by future investigators, especially as technology continues to grow and become further integrated into education and clinical practice over time. Students and clinicians show increasing interest in the use of digital resources to learn and review information quickly and efficiently. The [redacted] Nurse Anesthesia YouTube channel offers a professionally validated avenue for the publication of future educational videos. The use of adjunct videos of this nature for both SRNA education and CRNA continuing education can be expanded to include hundreds of topics. CRNAs taking the recertification examination to maintain their licensure may also take interest in this learning format, especially if improvements to SEE and NCE scores are clearly demonstrated.

Dissemination and Professional Reporting

Preliminary results of this project were reported at the New Jersey state level in October, 2019. Professional reporting of data and analysis gained from this video-review intervention will also be disseminated on a national level at the Assembly of Didactic and Clinical Educators (ADCE) yearly conference in the form of a poster presentation from February 19, 2020 to February 22, 2020. This conference specifically targets all members of nurse anesthesia education with an aim to discuss challenges in teaching and formulate plans to promote best practice. Lastly, the authors plan to submit the results of this project the American Association of Nurse Anesthetists' (AANA) peer reviewed journal for publication. This forum will allow

findings to be distributed to a wide range of nurse anesthesia students as well as actively practicing CRNAs.

Conclusion

The implementation of this video adjunct review noticeably improved student's perceptions of self-efficacy and confidence. The D4 cohort showed a greater improvement to self-efficacy/confidence compared to the D3 cohort, likely due to the nature of their junior status in the program at the time of implementation and lack of comparative clinical time working directly with the anesthesia machine. While the results relating to knowledge levels were not significant, the authors are eager to learn if there is an increase in students' overall scores on the equipment and technology portion of the SEE and NCE when compared against historical data now that this area of weakness has been identified by students and nurse anesthesia faculty.

Summary

SRNAs face a daunting task as they must acquire and retain a vast amount of didactic knowledge. Accomplishing this alone is not enough, as the SRNA must then apply this knowledge clinically in a skillful and efficient manner in order to provide safe quality anesthesia care. After graduating, the educational process has not ended. CRNAs must maintain and improve their skillset throughout their career in order to maintain strong evidence-based practices. Safe and efficient use of equipment and technology is integral to practice as failure to do so can result in adverse patient outcomes (Mehta et al., 2013) as well as poor utilization of healthcare resources. Our adjunct video review demonstrated significant improvements to SRNA confidence by providing SRNAs with a new evidence-based learning resource which helps translate didactics to clinical application. The outcomes of this project can be translated to other institutions and other topics in order to improve educational and clinical outcomes.

References

American Society of Anesthesiologists (2008). *Guideline for designing pre-anesthesia checkout procedures*. Retrieved from https://www.asahq.org/media/sites/asahq/files/public/resources/clinical-resources/finalcheckoutdesignguidelines.pdf

Bergl, P., & Muntz, M. (2016). Using social media to enhance health professional education. *The Clinical Teacher, 13,* 399-404. doi: 10.1111/tct.12594

Carroll, C. L., Bruno, K., & vonTschudi, M. (2016). Social media and free open access medical education: The future of medical and nursing education? *American Journal of Critical Care Nurses, 25*(1), 93-96. doi: 10.4037/ajcc2016622

Cheston, C. C., Flickinger, T. E., & Chisolm, M. S. (2013). Social media use in medical education: A systematic review. *Academic Medicine, 88*(6), 893-901. doi: 10.1097/ACM.0b013e1828ffc23

Chi, D., Pickrell, J., Riedy, C. (2014). Student learning outcomes associated with video vs. paper cases in a public health dentistry course. *Journal of Dental Education, 78*(1), 24-30. Retrieved from http://www.jdentaled.org/content/jde/78/1/24.full.pdf

Chiu, M., Arab, A. A., Elliott, R., & Naik, V. N. (2011). An experiential teaching session on the anesthesia machine check improves resident performance. *Canadian Journal of Anesthesia/Journal Canadian Danesthésie, 59*(3), 280-287. doi:10.1007/s12630-011-9649-5

Cooper, J. B., Newbower, R. S., & Kitz, R. J. (1984). An analysis of major errors and equipment failures in anesthesia management: Considerations for prevention and detection. *Anesthesiology, 60*, 34-42. Retrieved from: http://anesthesiology.pubs.asahq.org/journal.aspx

Ehrenfeld, J. M., Urman, R. D., & Segal, S. (2016). Anesthesia student survival guide: A case-based approach (2nd ed.). New York, NY: Springer.

Fasting, S. & Gisvold, S. E. (2002). Equipment problems during anesthesia – are they a problem? *British Journal of Anaesthesia, 89* (6), 825-831. doi: 10.1093/bja/aef276

Food and Drug Administration (1993). *Anesthesia apparatus checkout recommendations.* Retrieved from: http://www.fda.gov/cdrh/humfac/anesckot.html

Gillispie, V. (2016). Using the flipped classroom to bridge the gap to generation Y. *Ochsner Journal*, *16*(1), 32–36. Retrieved from http://search.proquest.com/docview/2158211884/

Grosser, J., Bientzle, M., Shiozawa, T., Hirt, B., & Kimmerle, J. (2018). Acquiring clinical knowledge from an online video platform: A randomized controlled experiment on the relevance of integrating anatomical information and clinical practice. *Anatomical Sciences Education*. https://doi.org/10.1002/ase.1841

Hopkins, L., Hampton, B. S., Abbott, J. F., Buery-Joyner, S. D., Craig, L. B., Dalrymple, J. L., ... Page-Ramsey, S. M. (2018). To the point: Medical education, technology, and the millennial learner. *American Journal of Obstetrics and Gynecology*,*218*(2), 188-192. doi: 10.1016/j.ajog.2017.06.001

Johnston, A. NB., Barton, M. J., Williams-Pritchard, G. A., & Todorovic, M. (2018). YouTube for millennial nursing students; using internet technology to support student engagement with bioscience. *Nurse Education in Practice, 31*, 151-155. doi: 10.1016/j.nepr.2018.06.002

Kandler, L., Tscholl, D. W., Kolbe, M., Seifert, B., Spahn, D. R., & Noethiger, C. B. (2016). Using educational video to enhance protocol adherence for medical procedures. *British Journal of Anaesthesia, 116*(5), 662-669. doi: 10.1093/bja/aew030

Keller, J. M. (1987). Development and use of the ARCS model of instructional design. *Journal of Instructional Development, 10*(3), 2–10. https://doi.org/10.1007/BF02905780

Keller, J. M. (2010). *Motivational design for learning and performance: The ARCS model approach*. New York: Springer.

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

Kusurkar, R. (2013). Critical Synthesis Package: General Self-Efficacy Scale (GSE). *MedEdPORTAL Publications*. doi:10.15766/mep_2374-8265.9576

Larson, E. R., Nuttall, G. A., Ogren, B. D., Severson, D. D., Wood, S. A., Tosher, L. C.… & Shirk Marienau, M. E. (2007). A prospective study on anesthesia machine fault identification. *Anesthesia and Analgesia, 104* (1), 154-156. doi: 10.1213/01.ane.0000250225.06165.4b

McLain, N., Biddle, C., & Cotter, J. (2012). Anesthesia clinical performance outcomes: Does teaching method make a difference? *AANA Journal,80*(4), S11-S16. Retrieved from https://login.proxy.libraries.rutgers.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=c8h&AN=108141019&site=ehost-live

Mehta, S. P., Eisenkraft, J. B., Posner, K. L., & Domino, K. B. (2013). Patient injuries from anesthesia gas delivery equipment. *Anesthesiology,119*(4), 788-795. doi: 10.1097/aln.0b013e3182a10b5e

Moghavvemi, S., Sulaiman, A., Jaafar, N. I., & Kasem, N. (2018). Social media as a

complementary learning tool for teaching and learning: The case for YouTube. *The International Journal of Management Education, 16*, 37-42. doi: 10.1016/j.ijme.2017.12.001

Moreno-Duarte, I., Montenegro, J.Balonov, K., & Schumann, R. (2017). Increased resistance to flow and ventilator failure secondary to faulty CO2 absorbent insert not detected during automated anesthesia machine check: A case study report. *Anesthesia and Analgesia Case Reports, 8*, 192-196. doi: 01.1213/XAA.0000000000000464

Nettle, M. (2018). Social media in medical education: Can you trust it? Yes. *Emergency Medicine Australiasia, 30*(3), 416-417. doi: 10.111/1742-6723.13100

Roland, D., & Brazil, V. (2015). Top 10 ways to reconcile social media and 'traditional' education in emergency care. *Emergency Medicine Journal, 32*, 819-822. doi: 10.1136/emermed-2015-205024

Rose, G., & McLarney, J.T. (2014). *Anesthesia Equipment Simplified*, New York: McGraw Hill Education.

Schwarzer, R., & Jerusalem, M. (1995). Generalized Self-Efficacy scale. In J. Weinman, S. Wright, & M. Johnston, *Measures in health psychology: A user's portfolio. Causal and control beliefs* (pp. 35-37). Windsor, England: NFER-NELSON.

Shahriari, A., Khooshideh, M., & Sheikh, M. (2016). Pneumothorax caused by anesthesia circuit misconnection. *Anesthesia, Pain & Intensive Care, 20* (2), 214-216. Retrieved from: http://www.apicareonline.com/oldsite/pneumothorax-caused-by-anesthesia-circuit-misconnection/

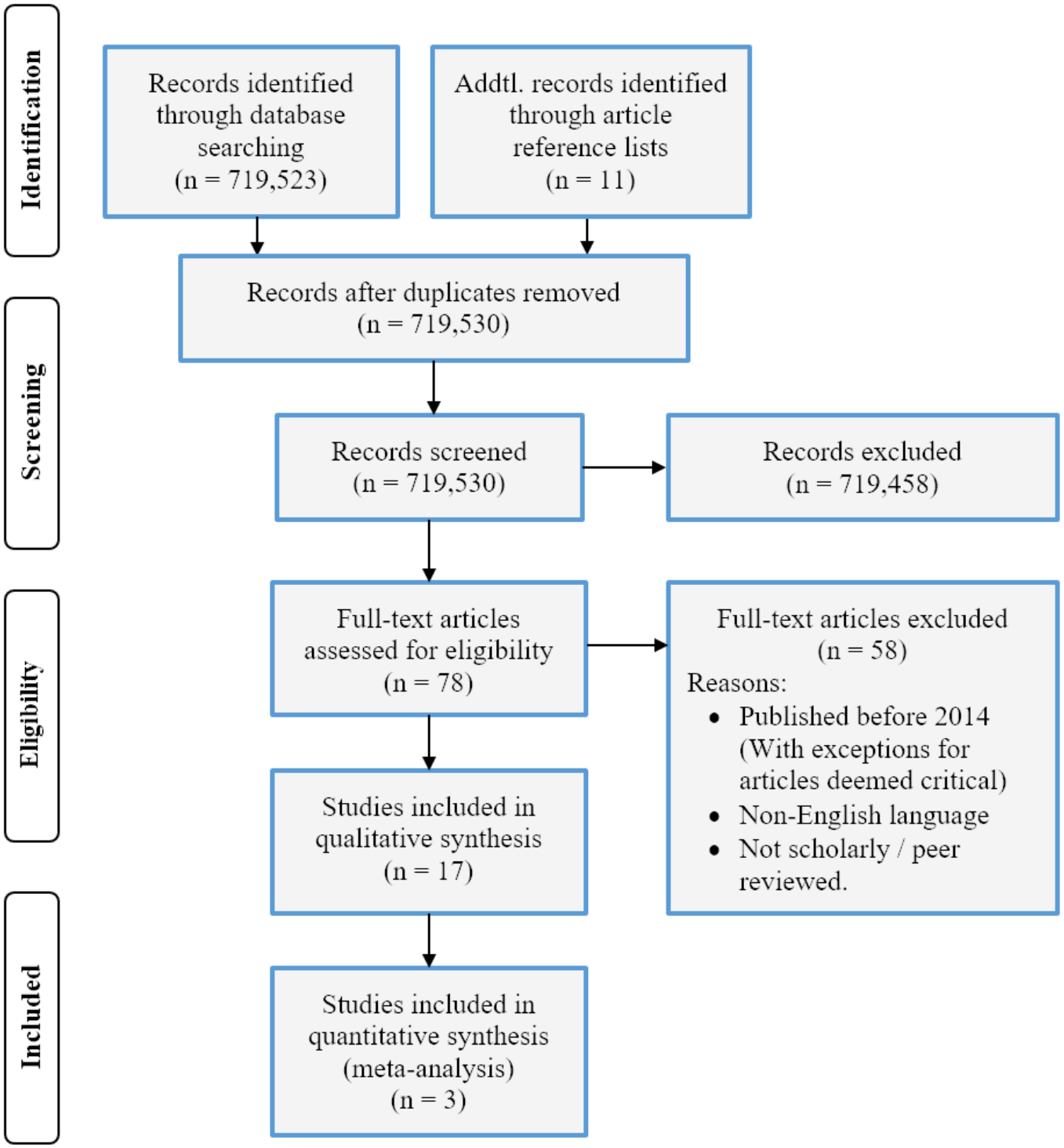
Sterling, M., Leung, P., Wright, D., Bishop, T. F. (2017). The use of social media in graduate

medical education: A systematic review. *Academic Medicine, 92*(7), 1043-1056. doi: 10.1097/ACM.0000000000001617

Sutherland, S., & Jalali, A. (2017). Social media as an open-learning resource in medical education: Current perspectives. *Advances in Medical Education and Practice, 8,* 369-375. doi: 10.2147/AMEP.S112594

Zoghbi, V., Caskey, R. C., Dumon, K. R., Soegaard Ballester, J. M., Brooks, A. D., Morris, J. B., & Dempsey, D. T. (2018). “How to” videos improve residents performance of essential perioperative electronic medical records and clinical tasks. *Journal of Surgical Education, 75*(2), 489-496. doi: 10.1016/j.jsurg.2017.07.009.

Appendix A: PRISMA Table for Review of Literature



Appendix B: Evidence Table

EBP Question: Does the implementation of a video learning adjunct on applying the fundamentals of the anesthesia machine to clinical practice improve the confidence and clinical performance of SRNAs during their nurse anesthesia residency resulting in improved anesthesia quality and safety?

Article	Authors / Citation	Evidence Type	Sample, Sample Size & Setting	Study Findings	Limitations	Evidence Level & Quality
1	Chiu, M., Arab, A. A., Elliott, R., & Naik, V. N. (2011). An experiential teaching session on the anesthesia machine check improves resident performance. *Canadian Journal of Anesthesia/Journal Canadian Danesthésie,59*(3), 280-287. doi: 10.1007/s12630-011-9649-5	Quasi experimental study	Medical residents in training, 64 (37 PGY-1 in simulation group and 27 PGY-5 in control group). Setting: residency training program, classroom / simulation lab.	Junior residents who participated in the experiential teaching session (simulation) were able to identify more machine faults compared to seniors in the control group ($P < 0.001$). They also had higher checklist scores ($P <0.001$). The study was repeated when these junior residents became seniors. They retained more information versus the previous seniors as evidenced by better identification of machine faults and less time taken to perform machine checkout.	Small sample size; only compares 2 cohorts within a single school, leading to poor generalizability. Junior residents were not tested on baseline knowledge prior to the teaching intervention and may have possessed better knowledge versus senior residents (control group).	Level II with good quality literature review and evidence.
2	Chi, D., Pickrell, J., Riedy, C. (2014). Student learning outcomes associated with video vs. paper cases in a public health dentistry course.	Retrospective cohort study with a historical control group	Authors measured dental students affective and cognitive learning outcomes	The use of video cases resulted in significantly improved outcome measures in all 12 areas measured. This included effectiveness, learning outcomes, cognition, empathy, and cultural competency.	Non-randomized design with potential for recall bias as video groups had previously utilized paper studies. Study limited to single	Level III with good integration of theory into study design, but overall low quality due to limitations and

	Journal of Dental Education, 78(1), 24-30. Retrieved from http://www.jdentaled.org/content/jde/78/1/24.full.pdf		among 2 cohorts. They compared those who utilized a video case (n=37) vs. those who utilized a paper case (n=75).		cohorts within a single school, limiting generalizability. Possible selection bias due to low response rates as students progressed in the program (approx. 32% response rate in second and fourth year students).	insufficient sample size for study design.
3	Hopkins, L., Hampton, B. S., Abbott, J. F., Buery-Joyner, S. D., Craig, L. B., Dalrymple, J. L., . . . Page-Ramsey, S. M. (2018). To the point: Medical education, technology, and the millennial learner. *American Journal of Obstetrics and Gynecology,218*(2), 188-192. doi:10.1016/j.ajog.2017.06.001	Editorial; Non-experimental	N/A	Summarizes information about student learning preferences and different technological learning adjuncts available including YouTube and YouTube EDU. Includes information about potential risks and benefits of digital learning methods.	Limited by editorial nature; lack of scientific results.	Level IV, good quality exploratory/ general information.
4	McLain, N., Biddle, C., & Cotter, J. (2012). Anesthesia clinical performance outcomes: does teaching method	Randomized controlled crossover trial.	24 SRNAs randomly divided into 2 groups within simulation	Comparison of traditional SRNA instruction vs. video instruction on the topic of patient safety case scenarios. Included anesthetic crisis events related to	Small sample size within a single school and cohort. Lack of standardized data collection tool to	Level I with low quality results that are not generalizable.

	make a difference? *AANA Journal,80*(4), S11-S16. Retrieved from https://login.proxy.libraries.rutgers.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=c8h&AN=108141019&site=ehost-live		laboratory. Authors utilized a pre-test / post-test design.	malfunctioning "sabotaged" equipment. Teaching methods included video vignettes which had a significant effect on clinical performance and information recall.	assess level of knowledge application, so one was created by the authors. Due to nature of the sample and questionable reliability of the data collection tool, the study findings cannot be generalized. The authors recommend further study.	
5	Kandler, L., Tscholl, D. W., Kolbe, M., Seifert, B., Spahn, D. R., & Noethiger, C. B. (2016). Using educational video to enhance protocol adherence for medical procedures. *British Journal of Anaesthesia, 116*(5), 662-669. doi: 10.1093/bja/aew030	Prospective intervention study	Anesthesia teams assembled from a pool of 45 consultants, 100 residents, and 200 CRNAs/SRNAs were observed pre-video (N=202) and post-video implementation (N=223) in 7 operating areas with 30 individual ORs at the [redacted]	Observers indicated improved adherence to safety-critical tasks related to RSI in the post-video group. Failure of adherence rates for 13 out of 14 assessed tasks improved in the post-video group, with 8 of those task improvements deemed significant ($p<0.01$).	There was no way to determine whether or not all members of the anesthesia teams actually viewed the implemented educational video as it was published on the hospitals intranet with email reminders to view it sent to anesthesia staff. The selection of observed RSIs was dependent on the availability of the 5 observers, so selection bias cannot be excluded. Behavior of the study participants may have	Level II with low quality due to lack of literature review or reference to scientific evidence.

			Zurich, Switzerland.		been influenced by the presence of an observer for RSI. Single-center study, poor likelihood of reproducibility in other centers.	
6	Johnston, A. NB., Barton, M. J., Williams-Pritchard, G. A., & Todorovic, M. (2018). YouTube for millennial nursing students; using internet technology to support student engagement with bioscience. *Nurse Education in Practice, 31*, 151-155. doi: 10.1016/j.nepr.2018.06.002	Quasi-experimental study	An Australian tertiary education facility, spanning across 3 regional campuses with approximately 2500 students accessing the created YouTube page over its first 2 years.	Over 90% of in-house university students agreed or strongly agreed that videos in the developed course assisted their bioscience learning. Qualitative data collected found positive feedback regarding the developed YouTube videos in predetermined categories such as content quality, learning goal alignment, motivation, presentation, design, interaction usability, accessibility, reusability, feedback and adaptation, and workload.	The study did not directly address effect on student academic performance or clinical practice. Views were not restricted to the study population (nursing students); view counts and duration of views may be easily skewed by this uncontrolled variable.	Level III, good quality with transparency, self-reflection, and an abundant literature review.
7	Moghavvemi, S., Sulaiman, A., Jaafar, N. I., & Kasem, N. (2018). Social media as a complementary learning tool for teaching and learning: The case for YouTube. *The International Journal of Management Education, 16*, 37-42. doi:	Mixed-method	Qualitative stage: 30 business students ranging from undergraduate, postgraduate, full-time, and part-time, attending the [redacted]	Qualitative data revealed all students utilized YouTube for relaxation and entertainment; respondents felt YouTube helped solve academic problems and increase knowledge; almost all respondents suggested a video segment be incorporated into teaching sessions.	Quantitative study design was based on qualitative analysis of a small sample size within a single university. It is suggested that the scale developed by the authors to measure academic learning as one of the	Level III, good quality with adequate literature review and insightful interpretation of data.

	10.1016/j.ijme.2017.12.001		[redacted], Malaysia. Quantitative stage: 312 part-time and full-time students in the Faculty Business and Accountancy, [redacted]	Quantitative data was analyzed from results of 6-item Likert scale questionnaire. Over 70% of respondents reported using YouTube for academic learning, to learn how to solve problems, to get answers for some questions, and to learn new things. Authors reported that results from their study confirmed the effectiveness of YouTube video on students' learning.	determinants of using YouTube be validated and examined in future studies.	
8	Kelly, M., Lyng, C., McGrath, M., & Cannon, G. (2009). A multi-method study to determine the effectiveness of, and student attitudes to, online instructional videos for teaching clinical skills. *Nurse Education Today, 29*, 292-300. doi: 10.1016/j.nedt.2008.09.004	Multi-method study, randomized control, quasi-experimental post-test only control group	Nursing students attending the [redacted] Control group (N=4) taught clinical skills in traditional manner (lecture followed by supervised practice) Experimental group (N=6) viewed	No statistical significance found in clinical skills scores between experimental and control groups as measured by Objective Structural Clinical Examination assessment. Attitude questionnaire supported use of videos as an adjunct to traditional teaching methods as opposed to replacing lecturer demonstration.	Small sample size prohibited meaningful statistical analysis. Lack of voluntary participation may be attributed to perceived relationships between the authors/professors and students. Over 60% of questionnaire respondents reported being unable to download videos to their home computer.	Level II with low quality. Results are not generalizable due to insufficient sample size.

			instructional videos (no in-person lecture) prior to supervised practice. 204 students completed questionnaire on last day of the module.			
9	Zoghbi, V., Caskey, R. C., Dumon, K. R., Soegaard Ballester, J. M., Brooks, A. D., Morris, J. B., & Dempsey, D. T. (2018). "How to" videos improve residents performance of essential perioperative electronic medical records and clinical tasks. *Journal of Surgical Education, 75*(2), 489-496. doi: 10.1016/j.jsurg.2017.07.009.	Single-institution prospective study	11 interns from the general surgery residency program at the [redacted] PA.	Exposure to brief 2-3 minute "how to" videos significantly improved interns abilities to complete EMR tasks and improved time taken to complete each task as assessed by observers. A post-intervention survey also found interns to have improved self-reported confidence in performing these tasks and ability to do so during an emergency situation.	Small sample size in a single institution. Authors discussed challenges in recruiting volunteers. Timing of intervention would have been better suited at the start of the intern year (July) instead of in the middle of their first year to control for improvements based on comfort and repetition alone.	Level III, low quality due to subpar review of literature guiding the study.
10	Sutherland, S., & Jalali, A. (2017). Social media as an open-learning resource in medical education: Current	Literature review	Review of 13 studies compiled from a search of MEDLINE,	Published research evaluating open-learning resources (including YouTube, Facebook, and Twitter) is lacking.	Search was limited to empirically based studies, may have excluded relevant articles. Additional	Level V, low level quality as conclusions cannot be drawn.

	perspectives. *Advances in Medical Education and Practice, 8*, 369-375. doi: 10.2147/AMEP.S112594		ERIC, Embase, PubMed, Scopus, and Google Scholar from 2012-2017.	YouTube appears to have little educational value due to the variable, unsupervised, unregulated nature of content.	empirical articles were found by the authors but not available in peer-reviewed journals at time of publishing.	
11	Sterling, M., Leung, P., Wright, D., Bishop, T. F. (2017). The use of social media in graduate medical education: A systematic review. *Academic Medicine, 92*(7), 1043-1056. doi: 10.1097/ACM.0000000000001617	Systematic review	Review of 29 studies through November 2015, complied from a search of Medline, Embase, Cochrane, PubMed, Scopus, and ERIC.	Overall effect of social media on residency education, recruitment, and professionalism is mixed and quality of existing studies is lacking. YouTube and wikis found to be commonly used to teach technical skills and promote self-efficacy.	Majority of studies reviewed were exploratory in nature with limited high-quality research available. Many relevant studies were excluded due to lack of peer-review.	Level V, low quality due to inconclusive findings.
12	Nettle, M. (2018). Social media in medical education: Can you trust it? Yes. *Emergency Medicine Australiasia, 30*(3), 416-417. doi: 10.111/1742-6723.13100	Editorial; non-experimental	N/A	Discusses benefits of social media publications such as crowd-sourced review of information, real-time criticism, feedback, and dialogue, and ability to rapidly update content. The use of Gestalt ratings (with number of raters >42) are reliable in evaluation of online resources; rating/appraisal tools such as this along with crowed-sourced reviews may be used in the future to validate social media for medical education.	Lack of evidence behind some statements. Author has a competing interest listed.	Level V, low quality. Expertise of the author is not discernable; conclusions cannot be drawn.
13	Roland, D., & Brazil, V. (2015). Top 10 ways to reconcile social media	Editorial; non-	N/A	There is a plethora of ways to merge social media with ‘traditional’ education, including	Editorial – lack of scientific findings.	Level V with good quality. Adequate and

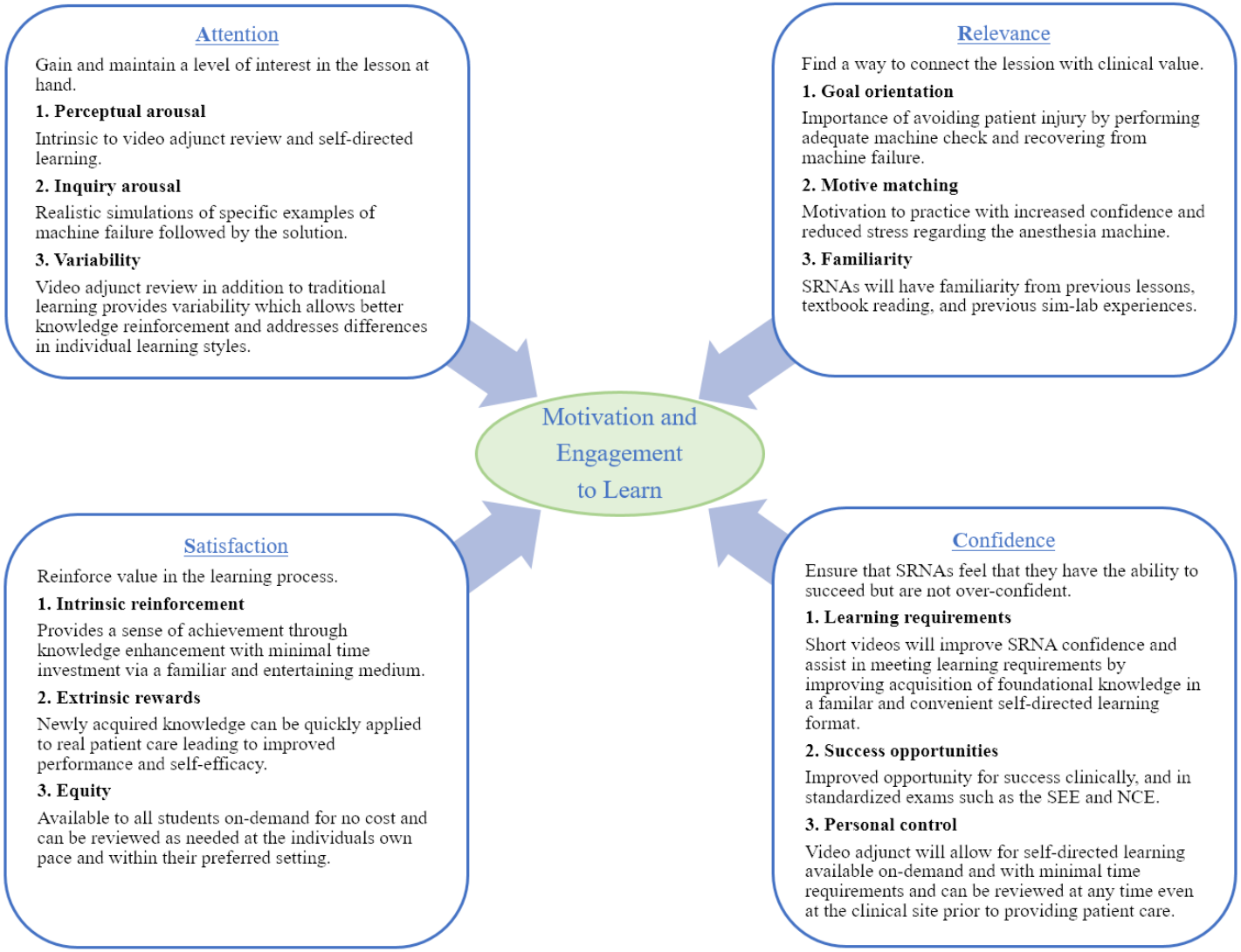
	and 'traditional' education in emergency care. *Emergency Medicine Journal*, *32*, 819-822. doi: 10.1136/emermed-2015-205024	experimental		the use of social media as a medium to create and distribute material. Learners still require skills to be developed in order to critically appraise research and educational content whether critiquing a peer-reviewed article or an online source.		up to date references to support opinions
14	Cheston, C. C., Flickinger, T. E., & Chisolm, M. S. (2013). Social medial use in medical education: A systematic review. *Academic Medicine*, *88*(6), 893-901. doi: 10.1097/ACM.0b013e1828ffc23	Systematic review	Review of studies from MEDLINE, CINAHL, ERIC, Embase, PsycINFO, ProQuest, Cochrane Library, Web of Science, and Scopus. Total of 14 studies met inclusion criteria during time period of 2006-2011.	Explores social media and its potential to enhance learning in medical education. Found a theme of favorable results related to learner satisfaction, knowledge, attitudes, and skills, suggesting that social media tools can safely be used in medical education and may have a positive impact on learner outcomes. Challenges addressed in incorporating social media included technical difficulties encountered by students and faculty and variable levels of learner participation.	Most studies were not deemed high quality. Relevant, high quality articles may have been published since the time of authors' initial literature review. Articles did not always clearly define the social media technology being studied. Studies were too heterogeneous to perform sensitivity, subgroup, or meta-analysis.	Level V, good quality data
15	Mehta, S. P., Eisenkraft, J. B., Posner, K. L., & Domino, K. B. (2013). Patient injuries from anesthesia gas delivery equipment. *Anesthesiology,11* (4), 788-795. doi:	Retrospective study	9806 claims from the ASA Closed Claims Project database from 1970-2011	Anesthesia gas delivery claims have decreased significantly, with less severe reported outcomes overall. 85% of claims involved provider error (with or without equipment failure)	Only addressed claims made against anesthesia providers; authors noted that claims/lawsuits may have been aimed solely at equipment manufacturers	Level III, good quality with insightful interpretation of data

	10.1097/aln.0b013e3182a10b5e			35% were deemed preventable by preanesthesia machine check 80% of claims from 1990-2011 resulted in a lawsuit and median payout of $202,980		
16	Shahriari, A., Khooshideh, M., & Sheikh, M. (2016). Pneumothorax caused by anesthesia circuit misconnection. *Anesthesia, Pain & Intensive Care, 20* (2), 214-216. Retrieved from: http://www.apicareonline.com/oldsite/pneumothorax-caused-by-anesthesia-circuit-misconnection/	Case study	N = 1 male patient in an undisclosed operating room	Despite passing a pre-anesthetic leak test, a misconnection of the anesthesia circuit led to elevated airway pressures and eventual pneumothorax after induction of anesthesia	Single case report involving an older anesthesia machine model	Level V, good quality with logical arguments for improvements
17	Fasting, S. & Gisvold, S. E. (2002). Equipment problems during anesthesia – are they a problem? *British Journal of Anaesthesia, 89* (6), 825-831. doi: 10.1093/bja/aef276	Retrospective chart review	83,154 anesthetic cases reviewed from a 5-year period (1996-2000) in [redacted] Norway	Overall frequency of anesthetic equipment problems during general anesthesia was 0.23%, with 1/3 of the problems involving the anesthesia machine and 1/4 of the problems involving human error. Common problems included gas leaks, misconnections, malfunctioning one-way valves, and inadequate pre-use checks	Data collection was based off of anesthetist indicating an “intraoperative problem” as part of the standard anesthetic record and therefore cannot rule out underreporting	Level III, good quality data
18	Larson, E. R., Nuttall, G. A., Ogren, B. D., Severson, D. D., Wood,	Prospective study	87 anesthesia providers in attendance at a	Out of 5 preset faults, the average number identified by participants was 3.1; participants with more	No checklist to follow; subjects may or may have had prior	Level II, low quality due to lack of

	S. A., Tosher, L. C.… & Shirk Marienau, M. E. (2007). A prospective study on anesthesia machine fault identification. *Anesthesia and Analgesia, 104* (1), 154-156. doi: 10.1213/01.ane.0000250225.06165.4b		national meeting in a large academic medical center	than 7 years of experience detected the fewest number of faults (2.3). Despite improvements in anesthesia machines and in publication of checkouts, providers continue to have problems detecting machine faults	familiarization with utilized machine; potential for increased fault detection secondary to participants talking with one another; participants may have had increased vigilance in looking for faults due to the nature of the study	literature review; definitive conclusions cannot be drawn
19	Moreno-Duarte, I., Montenegro, J.Balonov, K., & Schumann, R. (2017). Increased resistance to flow and ventilator failure secondary to faulty CO2 absorbent insert not detected during automated anesthesia machine check: A case study report. *Anesthesia and Analgesia Case Reports, 8*, 192-196. doi: 01.1213/XAA.0000000000000464	Case study	1 Drager Apollo anesthesia machine	After successfully passing an automated pre-anesthesia machine check, a Drager Apollo anesthesia machine was set to mechanically ventilate a patient immediately after induction of anesthesia. Alarms and indications of circuit leak, failure to achieve inspiratory pressures and tidal volumes were immediately encountered and anesthetic care was adjusted to Total IV Anesthesia and manual bag-valve ventilation. A broken protective filter within the CO2 absorbent insert was only found to be at fault after a detailed investigation.	Single case report in an institution that utilizes non-disposable CO2 absorbents	Level 5, low quality as conclusions and solutions to problem at hand are not offered
20	Cooper, J. B., Newbower, R. S., & Kitz, R. J. (1984). An analysis of major errors	Mixed-method, retrospective,	139 anesthesia providers from 4 hospitals in the Boston	1089 preventable anesthesia-related “critical incidents” were identified through staged interviews of anesthesia providers;	Bias of reporting by anesthesia providers; incomplete reporting;	Level 2, sufficient sample size but low quality due

	and equipment failures in anesthesia management: Considerations for prevention and detection. *Anesthesiology, 60*, 34-42. Retrieved from:	prospective study	metropolitan area	over 70 incidents identified as contributing to substantive negative patient outcome	inconsistency in categorizing incidents	to absence of literature review

Appendix C: Concept Map of Adapted Keller ARCS Model of Instructional Design



Adapted from “ARCS Categories” by J. M. Keller, retrieved from: https://www.arcsmodel.com/arcs-categories

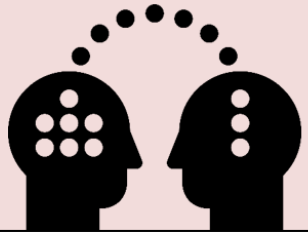
Appendix D: Recruitment Flyer

RUTGERS
School of Nursing

SRNAs: Would you like to improve your anesthesia machine knowledge & confidence?

Consider participating in our research study:

Anesthesia Machine Fundamentals: A Video Review



Seeking participants within the [redacted] to view a series of short evidence-based YouTube videos covering:

- Anesthesia machine **fundamentals** of operation
- Steps in performing a thorough **machine checkout**
- Applying the fundamentals to 4 of the **most common anesthesia machine models** utilized clinically
- Clinical case scenarios **identifying and safely recovering from intraoperative anesthesia machine failure**

When & Where:

D4 Cohort:
June 10th 2019
10:30am,
[redacted]

D3 Cohort:
June 17th 2019
10:30am,
[redacted]

Principal Investigators:
Stacie Tittamin, SRNA
[redacted]
Anthony Rizzuti, SRNA
[redacted]

RESERVED FOR IRB APPROVAL STAMP
DO NOT REMOVE

Page 1 of 1 RF Version: 3.28.19

Rutgers, The State University of New Jersey

Appendix E: Informed Consent

RUTGERS

Rutgers School of Nursing
Stanley S. Bergen Building
Rutgers, The State University of New Jersey
65 Bergen Street
Newark, NJ 07101-1709

CONSENT TO TAKE PART IN A RESEARCH STUDY

TITLE OF STUDY:
Anesthesia Machine Fundamentals: Improving Clinical Performance Through Adjunct Video Review.

Time and location:
June 10th 2019 10:30am (D4 cohort) Rutgers University, [redacted]
June 17th 2019 10:30am (D3 cohort) Rutgers University, [redacted]

Investigators:
Anthony Rizzuti
[redacted]

Stacie Tittamin
[redacted]

This consent form is part of an implied consent process for a research study and it will provide information that will help you decide whether you want to take part in this study. It is your choice to take part or not. After all of your questions have been answered and if you wish to take part in the research study, you may select 'accept' on the Qualtrics website. You may keep this consent for your records. Your alternative to taking part in the research is not to take part in it.

Who is conducting this research study and what is it about?
You are being asked to take part in research being conducted by the above listed investigators, who are graduate students in Rutgers Nurse Anesthesia Program. The purpose of this study is to determine whether a video adjunct review will improve knowledge and self-confidence in nurse anesthesia students.

What will I be asked to do if I take part?
The workshop and survey will take about 30 minutes to complete. We anticipate that 45 subjects will take part in the study.

What are the risks and/or discomforts I might experience if I take part in the study?
Breach of confidentiality is a risk of harm but a data security plan is in place to minimize such a risk. Also, some questions may make you feel uncomfortable. If that happens, you can skip those questions or withdraw from the study altogether. If you decide to quit at any time before you have finished the survey your answers will NOT be recorded.

RESERVED FOR IRB APPROVAL STAMP
DO NOT REMOE

Are there any benefits to me if I choose to take part in this study?
There no direct benefits to you for taking part in this research. You will be contributing to knowledge about knowledge and self-confidence levels in nurse anesthesia students.

Will I be paid to take part in this study?
You will not be paid to take part in this study.

How will information about me be kept private or confidential?
All efforts will be made to keep your responses confidential, but total confidentiality cannot be guaranteed. We will not collect any information that can identify you or other subjects. Surveys will be conducted digitally utilizing Qualtrics software which is password protected, encrypted, and will only be accessed by the study team. IP addresses will not be collected. Responses will be deleted after data analysis is complete and study findings are professionally presented or published.

What will happen to information I provide in the research after the study is over?
Responses may be used or distributed to investigators for other research without obtaining additional informed consent from you.

What will happen if I do not want to take part or decide later not to stay in the study?
Your participation is voluntary. If you choose to take part now, you may change your mind and withdraw later. You may leave without turning in a completed form or by turning in a blank or incomplete form. However, once you turn in the form, you can no longer withdraw your responses as we will not know which ones are yours.

Who can I call if I have questions?
If you have questions about taking part in this study, you can contact the investigators listed at the top of page 1. You can also contact our faculty advisor: Maureen McCartney Anderson, DNP, CRNA/APN via telephone at: (973) 972-9617 or via email at: [redacted]

If you have questions about your rights as a research subject, you can call the IRB Director at: Newark HealthSci IRB (973)-972-3608 or the Rutgers Human Subjects Protection Program at: (973) 972-1149.

Please keep this consent form if you would like a copy of it for your files.

By beginning this research, you acknowledge that you have read the information and agree to take part in the research, with the knowledge that you are free to withdraw your participation without penalty.

RESERVED FOR IRB APPROVAL STAMP
DO NOT REMOVE

Appendix F: Letter of Cooperation

[redacted]

Date: 05/07/2019

Re: Letter of Cooperation For [redacted]

Dear Dr. Maureen McCartney Anderson,

This letter confirms that that I, as an authorized representative of [redacted] allow the Principal Investigator and Co-investigators access to conduct study related activities at the listed site(s), as discussed with the Principal Investigator and briefly outlined below, and which may commence when the Principal Investigator provides evidence of IRB approval for the proposed project.

- **Research Site(s)**: [redacted]
- **Study Purpose:** To demonstrate improvements in SRNA knowledge and confidence in the checkout, operation, and troubleshooting of the anesthesia machine through the creation and implementation of supplemental video resources.
- **Site(s) Support**: Utilization of unoccupied operating rooms will be provided for recording of anesthesia machine instructional videos, specifically with access to the following machines: Draeger Apollo, Draeger Perseus, GE Avance/Aespire, GE Aestiva 5.
- **Data Management:** No data collection or analysis will be performed on site. All video recording will take place during OR downtime and will not include any hospital staff, patients, or any information that would be identifying to the site itself.
- **Anticipated End Date:** June 17, 2019

We understand that this site's participation will only take place during the study's active IRB approval period. All study related activities must cease if IRB approval expires or is suspended. I understand that any activities involving Personal Private Information or Protected Health Information may require compliance with HIPAA Laws and Rutgers Policy.

Our organization agrees to the terms and conditions stated above. If we have any concerns related to this project, we will contact the Principal Investigator. For concerns regarding IRB policy or human subject welfare, we may also contact the Rutgers IRB.

Regards,

[redacted]

Letter of Cooperation for Study: Anesthesia Machine Fundamentals: Improving Clinical Performance Through Adjunct Video Review

Appendix G: Perceived Confidence Survey

RUTGERS

Rutgers School of Nursing
Stanley S. Bergen Building
Rutgers, The State University of New Jersey
65 Bergen Street
Newark, NJ 07101-1709

Anesthesia Machine Fundamentals: Improving Clinical Performance Through Adjunct Video Review

Please **circle the appropriate number** to indicate your level of agreement with each statement.

Cohort: □ D3 □ D4

1. I can always manage to solve difficult anesthesia machine problems if I try hard enough.					
[Not at all true]	*1*	*2*	*3*	*4*	*[Exactly true]*
2. I am certain that I can accomplish my goals when operating an anesthesia machine at clinical.					
[Not at all true]	*1*	*2*	*3*	*4*	*[Exactly true]*
3. I am confident that I could deal efficiently with unexpected events related to the anesthesia machine.					
[Not at all true]	*1*	*2*	*3*	*4*	*[Exactly true]*
4. Thanks to my resourcefulness, I can handle unforeseen situations related to the anesthesia machine and delivery of a safe general anesthetic.					
[Not at all true]	*1*	*2*	*3*	*4*	*[Exactly true]*
5. I can solve most anesthesia machine related problems if I invest the necessary effort.					
[Not at all true]	*1*	*2*	*3*	*4*	*[Exactly true]*
6. I can remain calm when facing difficulties because I can rely on my coping abilities.					
[Not at all true]	*1*	*2*	*3*	*4*	*[Exactly true]*
7. When I am confronted with an anesthesia machine related problem, I can find several solutions.					
[Not at all true]	*1*	*2*	*3*	*4*	*[Exactly true]*
8. If I am in trouble (related to the anesthesia machine) I can think of something to do.					
[Not at all true]	*1*	*2*	*3*	*4*	*[Exactly true]*
9. I can handle whatever anesthesia machine related challenge comes my way clinically.					
[Not at all true]	*1*	*2*	*3*	*4*	*[Exactly true]*
10. **D4 only:** I am confident in my readiness to successfully operate the anesthesia machine at my next clinical rotation.					
[Not at all true]	*1*	*2*	*3*	*4*	*[Exactly true]*
11. I can currently achieve a satisfactory score in the equipment and technology portion of the Self-Evaluation Exam (SEE) and/or National Certification Exam (NCE).					
[Not at all true]	*1*	*2*	*3*	*4*	*[Exactly true]*
12. I will refer to the video review in the future if I encounter an unfamiliar anesthesia machine.					
[Not at all true]	*1*	*2*	*3*	*4*	*[Exactly true]*

Some survey questions adapted from the General Perceived Self-Efficacy Scale (Schwarzer & Jerusalem, 1995).

RESERVED FOR IRB APPROVAL STAMP
DO NOT REMOVE

Appendix H: Permission to use/modify General Self-Efficacy Scale

[redacted]

Permission granted

to use the General Self-Efficacy Scale for non-commercial reseach and development purposes. The scale may be shortened and/or modified to meet the particular requirements of the research context.

http://userpage.fu-berlin.de/~health/selfscal.htm

You may print an unlimited number of copies on paper for distribution to research participants. Or the scale may be used in online survey research if the user group is limited to certified users who enter the website with a password.

There is no permission to publish the scale in the Internet, or to print it in publications (except 1 sample item).

The source needs to be cited, the URL mentioned above as well as the book publication:

Schwarzer, R., & Jerusalem, M. (1995). Generalized Self-Efficacy scale. In J. Weinman, S. Wright, & M. Johnston, *Measures in health psychology: A user's portfolio. Causal and control beliefs* (pp.35-37). Windsor, UK: NFER-NELSON.

[redacted]

Appendix I: Knowledge Assessment Survey

RUTGERS

Rutgers School of Nursing
Stanley S. Bergen Building
Rutgers, The State University of New Jersey
65 Bergen Street
Newark, NJ 07101-1709

Anesthesia Machine Fundamentals: Improving Clinical Performance Through Adjunct Video Review

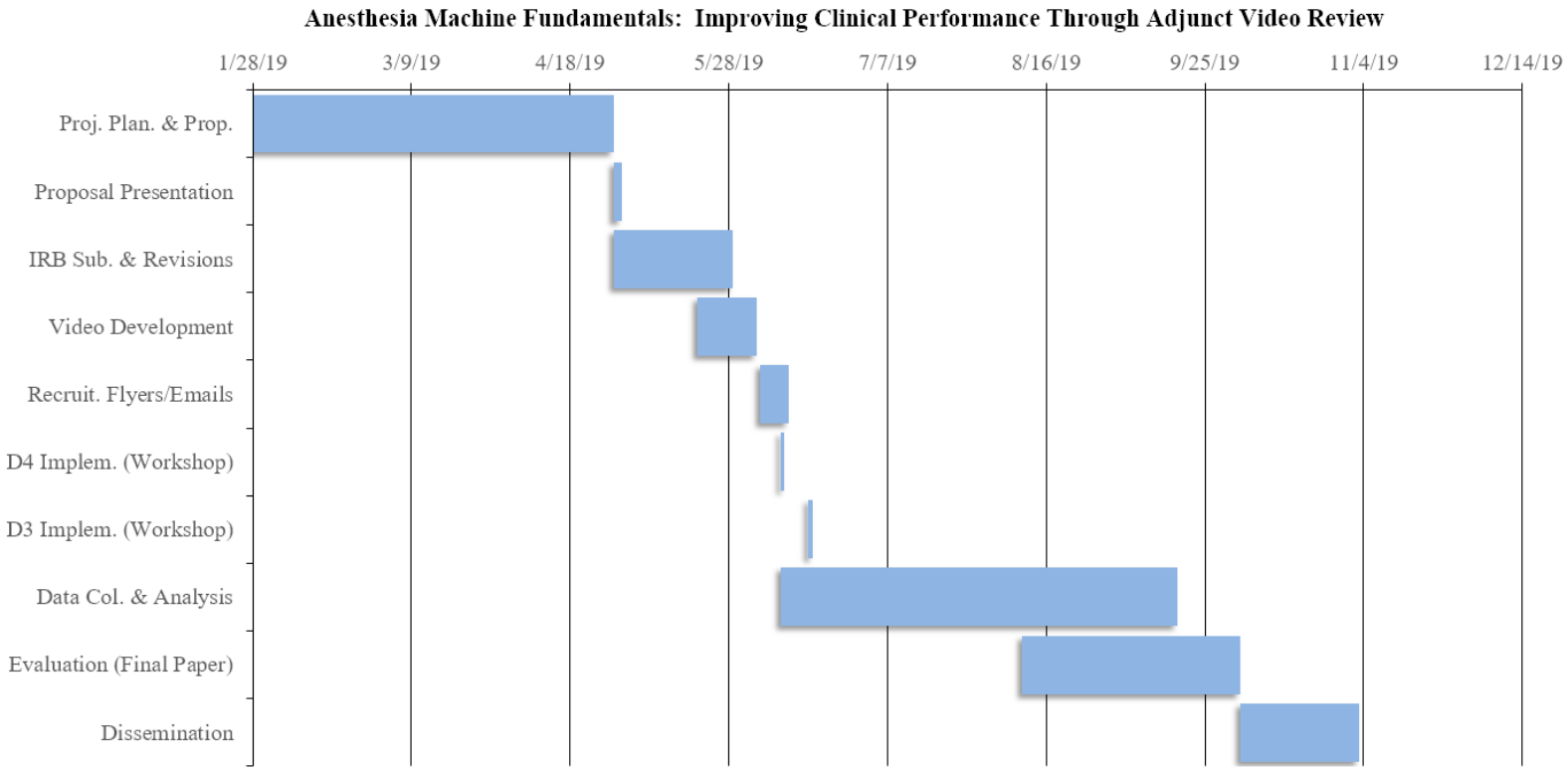
Please select the most appropriate answer choice for each of the following questions.

Cohort: ☐ D3 ☐ D4

1. Which machine check should be performed prior to every case?
   A. Scavenging system test.
   B. Full machine check-out.
   C. Oxygen sensor calibration.
   D. Leak test.
   E. Hypoxic guard.
2. During a case, you notice that the ETCO2 waveform is slowly rising and is no longer returning to baseline. What action is most appropriate to correct this as safely and quickly as possible?
   A. Replace the CO2 absorbent canister.
   B. Increase the minute volume.
   C. Increase fresh gas flows above the patient's minute ventilation.
   D. Replace the expiratory valve.
   E. Call for help, disconnect the patient from the anesthesia machine, and ventilate with a BVM.
3. After induction of general anesthesia, the anesthetist is unable to ventilate the patient and is unable to achieve a peak pressure greater than 12cmH2O. The ETT cuff is adequately inflated and all connections appear to be secure. What is the most likely cause of this failure to ventilate?
   A. Malfunction of the hypoxic guard.
   B. APL valve failure in the open position.
   C. Damaged CO2 absorber cannister.
   D. Unidirectional valve stuck open.
   E. Bronchospasm.
4. The SRNA performs a positive pressure leak test and notes that the bag inflates to 30cmH2O but over the course of 15 seconds, the pressure decreases to 20cmH2O. The SRNA will:
   A. Perform the test again with a higher O2 flow.
   B. Examine the machine to determine the source of the leak.
   C. Notify their preceptor.
   D. Proceed with the case anyway.
   E. Replace the leaky APL valve.

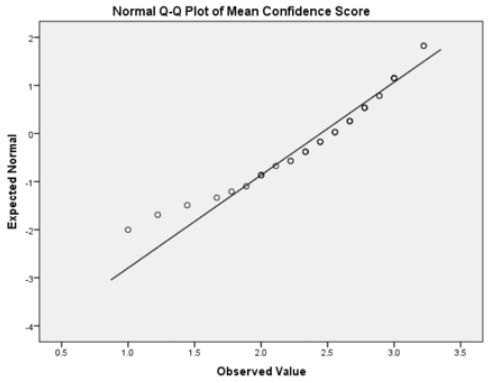
5. Open scavenging systems offer better patient safety compared to closed scavenging systems.
   A. True.
   B. False.
   C. Unable to determine without additional information.
6. You are working with an unfamiliar anesthesia machine / vaporizer and notice mid-way through a case that the volatile agent in use has nearly run empty. What is the best course of action?
   A. Disconnect patient from the circuit, refill vaporizer, reconnect patient, increase fresh gas flow rate.
   B. Turn vaporizer to "T" marking, refill vaporizer, turn vaporizer on to previous concentration.
   C. Refill vaporizer, increase fresh gas flow rate.
   D. Decrease fresh gas flow rate, turn vaporizer off, refill vaporizer, turn vaporizer on to previous concentration, increase fresh gas to previous flow rate.
   E. Switch to TIVA or a different agent – it is never safe to refill the vaporizer during a case.

Appendix J: Project Timeline



Appendix K: Data Analysis

Table 1. Normality tests



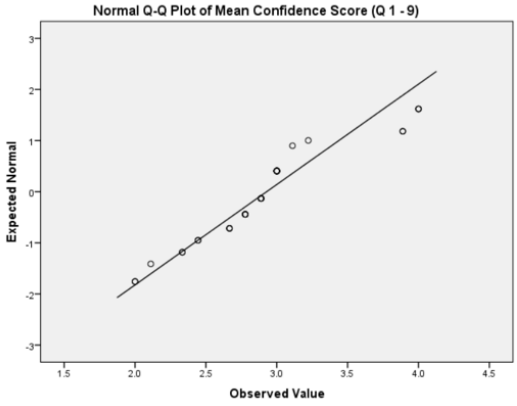
Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Mean Confidence Score	.118	43	.149	.939	43	.024

a. Lilliefors Significance Correction

Mean Confidence Score (Q1 - 9) Pre-Intervention

Field	Min	Max	Mean	Median	Standard Deviation	Variance	Responses
Mean Confidence Score	1.00	3.22	2.45	2.56	0.51	0.26	43



Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Mean Confidence Score (Q 1 - 9)	.255	37	.000	.887	37	.001

a. Lilliefors Significance Correction

Mean Confidence Score (Q 1 - 9)

Field	Min	Max	Mean	Median	Standard Deviation	Variance	Responses
Mean Confidence Score (Q 1 - 9)	2.00	4.00	2.93	2.89	0.50	0.25	37

Table 2. Wilcoxon Signed-Ranks test of overall (combined) confidence scores pre-intervention and post-intervention

Ranks

		N	Mean Rank	Sum of Ranks
Score_Post - Score_Pre	Negative Ranks	4[a]	8.00	32.00
	Positive Ranks	28[b]	17.71	496.00
	Ties	5[c]		
	Total	37		

a. Score_Post < Score_Pre

b. Score_Post > Score_Pre

c. Score_Post = Score_Pre

Test Statistics[a]

	Score_Post - Score_Pre
Z	-4.346[b]
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Table 3. Wilcoxon Signed-Ranks test of junior confidence scores pre-intervention and post-intervention.

Ranks

		N	Mean Rank	Sum of Ranks
Mean_Conf_Post_D4 - Mean_Conf_Pre_D4	Negative Ranks	1[a]	3.00	3.00
	Positive Ranks	18[b]	10.39	187.00
	Ties	3[c]		
	Total	22		

a. Mean_Conf_Post_D4 < Mean_Conf_Pre_D4

b. Mean_Conf_Post_D4 > Mean_Conf_Pre_D4

c. Mean_Conf_Post_D4 = Mean_Conf_Pre_D4

Test Statistics[a]

	Mean_Conf_Post_D4 - Mean_Conf_Pre_D4
Z	-3.709[b]
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Table 4. Wilcoxon Signed-Ranks test of senior confidence scores pre-intervention and post-intervention.

Ranks

		N	Mean Rank	Sum of Ranks
Mean_Conf_Post_D3 - Mean_Conf_Pre_D3	Negative Ranks	3[a]	7.17	21.50
	Positive Ranks	11[b]	7.59	83.50
	Ties	1[c]		
	Total	15		

a. Mean_Conf_Post_D3 < Mean_Conf_Pre_D3

b. Mean_Conf_Post_D3 > Mean_Conf_Pre_D3

c. Mean_Conf_Post_D3 = Mean_Conf_Pre_D3

Test Statistics[a]

	Mean_Conf_Post_D3 - Mean_Conf_Pre_D3
Z	-1.951[b]
Asymp. Sig. (2-tailed)	.051

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Table 5. Wilcoxon Signed-Ranks test of overall (combined) knowledge survey scores post-intervention and delayed post-intervention. Percentage of correct answers converted to raw scores (0-6).

Ranks

		N	Mean Rank	Sum of Ranks
Delayed_Post_Know_Test_Score - Post_Know_Test_Score	Negative Ranks	15[a]	17.60	264.00
	Positive Ranks	18[b]	16.50	297.00
	Ties	7[c]		
	Total	40		

a. Delayed_Post_Know_Test_Score < Post_Know_Test_Score

b. Delayed_Post_Know_Test_Score > Post_Know_Test_Score

c. Delayed_Post_Know_Test_Score = Post_Know_Test_Score

Test Statistics[a]

	Delayed_Post_Know_Test_Score - Post_Know_Test_Score
Z	-.305[b]
Asymp. Sig. (2-tailed)	.761
Exact Sig. (2-tailed)	.781
Exact Sig. (1-tailed)	.391
Point Probability	.017

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Table 6. Knowledge Assessment Results