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## "Use of Non-Technical Skills Training & Video Simulation to Improve Knowledge Among Nurse Anesthesia Trainees"

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Use of Non-Technical Skills Training & Video Simulation to Improve Knowledge Among Nurse

Anesthesia Trainees

DePaul University

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### Abstract

**Background:** The transition from didactic component to clinical practice is challenging for nurse anesthesia trainees. When faced with an airway crisis, successful management involves non-technical skills, which include recognition, decision-making, and prioritization. Limited data is available on the efficacy of instructional video on enhancing non-technical skills during airway crisis management among nurse anesthesia trainees.

**Purpose:** The purpose of this study was to examine the efficacy of instructional video simulation on enhancing the nurse anesthesia trainee's knowledge of recognition, decision-making, and prioritization during bronchospasm and laryngospasm airway crises.

**Methods:** A quasi-experimental pre-test and post-test design was used to investigate the effect of an instructional video simulating the proper non-technical skills of recognition, decision-making, and prioritization.

**Results:** A convenience sample of 27 second and third year nurse anesthesia trainees were recruited. A Wilcoxon Signed Ranks Test demonstrated that the median post-test scores were statistically higher than the median pre-test scores between pre and post-instructional video [ $Z = -4.473$ ;  $p = 0.000$  (2-tailed)] with adequate pre and post-test Kuder-Richardson-20 (KR-20) scores (0.533, 0.686). Specifically, post-test median prioritization scores for bronchospasm and laryngospasm were statistically higher than median pre-test scores [ $t = -5.366$ ;  $p = 0.000$  (2-tailed)]; [ $t = -8.588$ ;  $p = 0.000$  (2-tailed)].

**Conclusion:** The findings demonstrate the effectiveness of instructional video simulation on non-technical skills, specifically prioritization, during airway crises such as bronchospasm and laryngospasm for nurse anesthesia trainees. According to the results, utilizing a pre-test/post-test

design and instructional video simulation improved non-technical skills knowledge among nurse anesthesia trainees.

*Keywords:* non-technical skills, recognition, decision-making, prioritization, airway crisis, bronchospasm, laryngospasm, nurse anesthesia trainees

## **Introduction**

### **Background and Significance**

Medical errors are defined as errors or mistakes committed by health professionals, which result in harm to the patient (National Center for Biotechnology Information, U.S. National Library of Medicine, 2017). Medical errors are distinct from malpractice, which arise from gross negligence, reprehensible ignorance, or criminal intent. Anesthesia occurs in a high stakes environment within the healthcare industry where human factors account for 80% of accidents across the board in high-risk organizations (Wunder, 2016). Non-technical skills have been linked to preventable medical errors. Strategies to prevent medical errors cannot solely focus on the development of clinical knowledge, but must also address non-technical skills (Gordon et al., 2016).

Non-technical skills include task management, team working, situation awareness, and decision-making (Fletcher, McGeorge, Flin, Glavin, & Maran, 2002; Hoff; Jameson, Hannan, & Flink, 2004; Runciman et al., 2008). Non-technical skills are not traditionally taught in the didactic portion of anesthesia curriculum despite strong evidential support that they are important factors for maintaining and improving patient safety (Gordon, Darbyshire, & Baker, 2012). Nurse anesthesia trainees have minimal clinical experience to develop non-technical skills prior to the transitions from didactic classroom style education to clinical residency (Lee et al., 2016).

Transitioning from the didactic component into clinical residency is a challenging phase for nurse anesthesia trainees. This transition period involves applying didactic knowledge and technical skills learned in the classroom to then performing anesthesia procedures in an operating room. Practicing anesthesia involves adequate technical and non-technical skills. Therefore,

teaching non-technical skills to nurse anesthesia trainees can improve the transition into clinical residency and aid in the delivery of competent anesthesia care that can lead to enhanced patient safety and prevent medical errors.

According to Gordon et al. (2016), “non-technical skills are the cognitive and interpersonal skills that complement an individual’s clinical knowledge and facilitate the effective delivery of safe care” (p. 1043). Flin and Patey (2011) measured non-technical skills with the Anaesthetists’ Non-Technical Skills (ANTS) taxonomy and behavior-rating tool. The first factor, Situational awareness comprises of gathering information, recognizing and understanding data, and anticipation. The second factor, Decision-making involves identifying options, balancing risk and selecting options, and re-evaluation. The third factor, Teamwork relates to coordinating activities with team members, exchanging information, using authority and assertiveness, assessing capabilities, and supporting others. Lastly, Task management encompasses planning and preparing, prioritizing, providing and maintaining standards, and identifying and utilizing resources (Flin & Patey, 2011). These elements can be utilized in the training of nurse anesthesia trainees in non-technical skill development with adoption to fit the practice context of the operating room in the U.S. (Wunder, 2016).

Development of an appropriate method of teaching anesthesia students non-technical skills is essential. Simulation allows nurse anesthesia trainees to experience the clinical setting in a low-risk environment. According to Sharpnack, Goliat, Baker, Rogers, and Shockey (2013), instructional video simulation proved to enhance learning in nursing students. This type of learning improved tests scores, and also increased student’s satisfaction (Sharpnack et al., 2013). A digital media intervention improved mean scores in ANTS for first year nurse anesthesia trainees (Wunder, 2016). Instructional video simulation, role-play, and observation

can be beneficial tools for nurse anesthesia trainees developing technical and non-technical skills in crisis situations prior to immersion into actual clinical practice (Gordon, Darbyshire, & Baker, 2012).

### **Problem Statement**

Although current research demonstrates that various instructional modalities can be used to teach non-technical skills, little is known about its effectiveness in improving knowledge as the nurse anesthesia student transitions from didactic classroom style education to clinical residency. There is also a lack of information on how instructional video simulation teaches non-technical skills, such as recognition, decision-making, and prioritization during specific airway crisis management of bronchospasm or laryngospasm. This knowledge gap must be examined in order to better prepare nurse anesthesia trainees with the appropriate non-technical skills for airway crisis management.

### **Purpose of the Project**

The purpose of this study is to examine the effectiveness of instructional video simulation on enhancing the nurse anesthesia trainee's knowledge of recognition, decision-making, and prioritization during bronchospasm and laryngospasm airway crises.

### **Clinical Questions**

The clinical questions are as follows:

- Does viewing an instructional video simulating the proper management of bronchospasm and laryngospasm improve the non-technical skill of *recognition* among nurse anesthesia trainees?



- Does viewing an instructional video simulating the proper management of bronchospasm and laryngospasm improve the non-technical skill of *decision-making* among nurse anesthesia trainees?
- Does viewing an instructional video simulating the proper management of bronchospasm and laryngospasm improve the non-technical skill of *prioritization* among nurse anesthesia trainees?

### **Literature Review**

A review of the literature was conducted using CINAHL, ProQuest Nursing & Allied Health Source, PubMed, and WorldCat. The following keywords were used: “non-technical skills;” “airway crisis;” “anesthesia;” “video simulation;” bronchospasm;” “laryngospasm;” “audiovisual;” “simulation;” “video learning;” and “decision making.” The time frame for the data retrieval was from 2008 to 2016 focusing on peer-reviewed nursing and medical journals. There were 15 journal articles retrieved from the computerized database search and they are used in this literature review. These journal articles are highly relevant to non-technical skills, nurse anesthesia trainees, airway crisis management, decision-making, and video simulation.

### **Non-Technical Skills**

According to Patey (2008), research has found that the majority of accidents involved human error with limitations including human performances and non-technical skills. Exploring human error and learning from adverse events can improve patient safety. For this reason, healthcare has adapted factors for safe practice from the aviation industry (Patey, 2008). Crew resource management, a specific form of training for qualified pilots, was designed to support safe and efficient operations of both an individual pilot and flight team (Patey,

2008). International aviation regulators mandated non-technical skills training in the form of crew resource management courses (Flin & Patey, 2011). Crew resource management training goals were to avoid, capture, and mitigate the consequences of error. Crew resource management courses that provided feedback to participants on their performance have been shown to minimize errors and maximize safety (Patey, 2008). Observation during simulation also revealed that poor performance of skills such as leadership, vigilance, and decision-making lead to more accidents (Patey, 2008). Instructional tools that enhance non-technical skills, such as those used in the aviation industry can decrease human error and improve patient safety.

Anesthesia providers were one of the first groups of healthcare professionals to investigate the underlying causes of adverse events (Patey, 2008). Patient care is highly complex and other problems such as comorbidities can cause uncertainty as to how organ systems will be affected by treatment. The anesthesia environment is clearly different from the aviation industry, however anesthesia providers utilize several aviation simulation trainings. The highly technical and sequential aspect of airline pilot-related tasks are similar to anesthesia provider-related tasks, which make it appealing to anesthesia providers to pursue a framework for the identification and assessment of non-technical skills they were witnessing. These non-technical skills can be defined as behaviors in the operating room not directly related to the use of medical equipment, drugs, or technical skills (Framework for observing and rating Anesthetists' non-technical skills (ANTS): ANTS system handbook, 2012). Instead, non-technical skills in the operating room encompass interpersonal and cognitive skills.

## **ANTS**

The ANTS rating tool was formulated to meet criteria similar to non-technical skills in aviation (Fletcher et al., 2003). A team of anesthesiologists and psychologists were assembled to

develop and test the reliability and validity of ANTS scale. “Data was derived on anesthetists’ behavior gathered from literature review, observations, interviews, surveys and incident analysis,” (Flin & Patey, 2011, p. 219). ANTS behavioral marker system is a taxonomy of non-technical skills that was developed specifically to evaluate an anesthesia provider (Fletcher et al., 2003).

Skills identified for the rating system of non-technical aspects of performance included four categories: task management, teamwork, situational awareness, and decision-making (Patey, 2008). Situational awareness includes elements of gathering information, recognizing and understanding, and anticipating critical situations (Flin & Patey, 2011). Decision-making entails identifying options, balancing risks and selecting options, and re-evaluating (Flin & Patey, 2011). Task management encompasses elements of planning and preparing, prioritizing, providing and maintaining standards, and identifying and utilizing resources (Flin & Patey, 2011). Teamwork consists of coordinating activities with team members, exchanging information, using authority and assertiveness, assessing capabilities, and supporting others (Flin & Patey, 2011). The ANTS framework includes a set of four point rating scales for rating observed behaviors with regard to the four categories of non-technical skills and their elements of observable behaviors (Flin & Patey, 2011). The four point grading scale rates each observable behavior as being poor (1), marginal (2), acceptable (3), and good (4). This paper focuses specifically on the non-technical skills recognition, decision-making, and prioritization.

### *Recognition*

Recognition is an element of situational awareness. This specific non-technical skill involves “interpreting information collected from the environment (with respect to existing knowledge) to identify the match or mismatch between the situation and the expected state, and

to update one's current mental picture" (Framework for observing and rating ANTS: ANTS system handbook, 2012, p. 12). Certain behavioral markers related to proper recognition include increased patient monitoring following changes in a patient condition and the ability to recognize and describe these changing patterns (Framework for observing and rating ANTS: ANTS system handbook, 2012). Recognition is important for determining if a problem exists.

### *Decision-Making*

Decision-making includes the skill "for reaching a judgment to select a course of action or make a diagnosis about a situation, in both normal conditions and in time-pressured crisis situations" (Framework for observing and rating ANTS: ANTS system handbook, 2012, p. 13). This non-technical skill allows the anesthesia provider to obtain differential diagnoses of a certain situation and determine the correct course of action. The anesthesia provider must then consider the advantages and disadvantages of different courses of action, while continually reevaluating the situation (Framework for observing and rating ANTS: ANTS system handbook, 2012). Decision-making is important for selecting and carrying out the correct actions during patient care.

### *Prioritization*

Prioritization is an element of task management. This specific non-technical skill involves "scheduling tasks, activities, issues, information channels, etc., according to importance (e.g. due to time, seriousness, plans); being able to identify key issues and allocate attention to them accordingly, and avoiding being distracted by less important or irrelevant matters" (Framework for observing and rating ANTS: ANTS system handbook, 2012, p. 8). Certain behavioral markers associated with proper prioritization include the ability to assess urgency of certain actions and develop an order of action during a crisis situation (Framework for observing

and rating ANTS: ANTS system handbook, 2012). Prioritization is important for determining which tasks are essential during critical situations.

### **Nurse Anesthetists' Non-Technical Skills**

According to Lyk-Jensen, Jepsen, Spanager, Dieckmann, & Ostergaard (2014), “developing a behavioral marker system of non-technical skills specifically for the nurse anesthetist would allow assessment and feedback on important individual skills” (p. 795). The behavioral markers ANTS (as described above) may not adequately describe the role and working conditions of nurse anesthetists compared to anesthesiologists. Nurse-Anesthetists' Non-Technical Skills (N-ANTS) address many of the same key non-technical skills, but is based off of a three-level hierarchy of categories, elements, and behavioral markers that illustrate positive and negative behaviors relating to safety in the operating room (Lyk-Jensen et al., 2014). “The differences in the behavioral markers may reflect the roles, tasks, and competence of the nurse anesthetist that do differ compared to anesthesiologists” (Lyk-Jensen et al., 2014, p. 799). This tool, N-ANTS, adds more specific guidelines on recognizing when to consult the anesthesiologist. The N-ANTS tool provides a framework for describing adequate non-technical skills for nurse anesthetists (Lyk-Jensen et al., 2014).

### **Non-Technical Skills Knowledge Gap**

Traditionally, training anesthesia providers and other healthcare professions emphasize the development of technical skills and implementation of didactic knowledge. Non-technical skills are not routinely taught and rarely addressed (Patey, 2008), but are a vital part of the dynamic operating room environment (Wunder, 2016). A systematic review of 22 studies on non-technical skills training and patient safety found that the key themes of non-technical skills training included error, communication, teamwork and leadership, systems, and situational

awareness (Gordon, Darbyshire, & Baker, 2012). These themes are most commonly taught to and assessed in trainees through simulation, role-play, and observation.

Nurse anesthesia trainees who are transitioning from didactic learning to clinical residency would benefit from learning non-technical skills through simulation. Therefore, incorporating non-technical skills into nurse anesthesia trainees' curriculum is essential. Literature supports the application of video simulation as the vehicle to teach non-technical skills. For the purpose of this project, airway crisis management of bronchospasm and laryngospasm can provide a real world example of how to use non-technical skills.

### **Teaching Clinical Non-Technical Skills**

In a study by Wunder (2016), the importance of teaching non-technical skills was addressed. The purpose of the study was to determine whether an educational intervention on non-technical skills could improve the performance of non-technical skills during an anesthesia crisis simulation (Wunder, 2016). This quasi-experimental pre-test/post-test study demonstrated that a three-hour digital media presentation on non-technical skills significantly improved post-test mean scores in first-year nurse anesthesia students during six simulated crisis scenarios.

The students were exposed to three crisis scenarios during the pretest. Following the non-technical skills instruction, the students were exposed to three different crisis scenarios during the post-test. After the implementation of non-technical skills instruction, post-test non-technical skills significantly increased in first-year nurse anesthesia students. Wunder (2016) also found no difference in mean scores according to age, gender, or years of intensive care unit experience groupings and that all participants gained non-technical skills equally from the intervention. These study findings suggest that non-technical skills are not inherent or acquired over time, but can be taught through instructional training.

Other methods of instruction have been reported to be effective in teaching non-technical skills. An intense surgical boot camp was found to be effective in transferring knowledge, improving technical skills, and increasing confidence levels in technical and non-technical skills at the beginning of a surgical training program (Heskin et al., 2015). According to Heskin et al. (2015), boot camp proved to be as effective as a distributed practice method of surgical training. This study showed the impact of training interventions in novice healthcare professionals.

#### *Audiovisual simulation*

With advances in technology and rising education costs, video simulation teaching modalities are being explored to enhance clinical skills. Video simulation is an inexpensive and efficient learning tool (Mohd Saiboon et al., 2014). Although this may be true, video simulation efficacy must be explored.

In a single-blinded randomized controlled trial among first-year medical students, Mohd Saiboon et al. (2014) compared the efficacy of a self-instruction video to face-to-face instruction for common emergency procedures. The study researchers shot a self-instruction video demonstrating common emergency procedures using video clips followed by the insertion of close up information to improve understanding. The results of the study showed an improved confidence level in the self-instruction video group with three out of the four skills: basic airway management, cervical collar application, manual cardiac defibrillation, and emergency extremity splinting. Students reported that increased confidence levels were attributed to the ability to review the self-instruction video multiple times and see the skills at a different angle that was not achievable in face-to-face instruction (Mohd Saiboon et al., 2014). This study provided evidence that video simulation was helpful in improving confidence, but it did not explore knowledge

improvement. Utilizing a pre-test and post-test with the same research could enhance student's knowledge.

Mobile-based video clips are another learning tool aimed at a younger and more technologically savvy cohort. Lee et al. (2016) performed a randomized controlled trial that studied the effect of mobile-based video clips on student nurse's learning motivation, competency, and satisfaction. Both groups were exposed to the video clip demonstrating urinary catheterization during a 90-minute lecture. However, the intervention group was allowed unlimited access to this video for the two weeks leading up to the urinary catheterization practice laboratory. This study revealed that continued access to the video clip significantly improved students' learning motivation, confidence, and satisfaction. Knowledge and skill performance scores were higher in the intervention group, but the results were not statistically significant (Lee et al., 2016). These results suggested that mobile-based video clips are valuable tools in improving nursing education.

Although video learning has primarily been used to improve psychomotor skills, its ability to improve critical thinking must be examined. Sharpnack, Goliat, Baker, Rogers, and Shockey (2013) performed a quasi-experimental pre-test post-test study that examined the effect of video simulation on critical thinking and competency scores among nursing students. Students were shown videotaped clinical scenarios that required critical thinking. Students then discussed appropriate responses to each scenario, which was followed by a debriefing. Viewing videotaped scenarios significantly increased post-test competency scores. Students found the videos helped demonstrate how expert nurses reached certain clinical decisions (Sharpnack et al., 2013). This study demonstrated that videotaped scenarios helped



students incorporate didactic knowledge into clinical practice by utilizing a pre-test post-test methodology.

Much of the research on the effects of video learning tools pertains to healthcare professionals outside of anesthesia. McLain, Biddle, and Cotter (2012) studied the effects of video learning among nurse anesthesia trainees. In a randomized controlled crossover trial, McLain et al. (2012) compared traditional teaching with audiovisual patient safety vignettes and examined their impact on nurse anesthesia trainees' recall and clinical performance. Nurse anesthesia trainees received either standard lecture in addition to patient safety vignettes or standard lecture in addition to written clinical scenarios on anesthesia apparatus failure crises. The results of this study demonstrated that patient safety vignettes significantly increased recall, but had mixed results for improving clinical performance. Patient safety vignettes significantly improved recognition and adjustment of malfunctioning suction, but did not significantly improve recognition and adjustment of a malfunctioning expiratory valve. This study indicated that patient safety vignettes have the potential to improve the application of didactic knowledge into practice. Utilizing video learning tools can help improve recall. Therefore, encompassing audiovisual techniques can be beneficial during the didactic portion of training.

Teaching clinical non-technical skills have been shown to improve knowledge, recall, and confidence amongst healthcare students. Despite this knowledge and research, there is a gap within the didactic portion of nurse anesthesia education, where most students have to develop and enrich non-technical skills during their clinical residency. Heightened awareness of non-technical skills prior to clinical residency can improve knowledge amongst nurse anesthesia trainees. By utilizing a pre-test post-test study design, knowledge improvement can be further

tested and with advances in technology and rising education costs, video simulation teaching modalities should be explored to enhance nurse anesthesia clinical residency skills.

### **Airway Crisis Management**

#### *Crisis*

A crisis is defined as a time when a difficult or important decision must be made; a time of intense difficulty or danger (English Oxford Dictionary, 2017). For anesthesia purposes, it is typically a brief, intense event that often inflicts harm or danger to a patient. The best way to prevent crisis, would be to prevent a situation; but on rare occasions, it is inevitable.

Events that trigger problems or crises do not occur at random. According to Gaba, Fish, Howard, and Burden (2015), crises emerge from three sets of conditions: latent errors, predisposing factors, and psychological precursors. Latent errors can result from administrative decisions regarding rapid turnover and lacking proper patient interviews, cost management, assignment of personnel for staffing, and also design of anesthesia equipment. Predisposing factors and psychological precursors refer to an anesthesia provider that commits to an unsafe act that triggers a problem and then becomes a crisis situation (Gaba et al., 2015).

Triggering events can come from the patient, surgery, anesthesia, and/or equipment. The patient may have underlying comorbidities that predispose him/her to harm while under anesthesia. Surgical stimulus alone can trigger crisis events of many physiological responses including bronchospasm and laryngospasm. Induction and maintenance of anesthesia can trigger life threatening airway crises as well, especially if the anesthesia is too light. Without proper non-technical skills and training, patient's lives can be in jeopardy. Lastly, equipment plays an important role in diagnosis of an airway crisis. For example, oxygen saturation, peak airway pressures, and ventilator alarms all can alert an anesthesia provider to an impending

crisis. Reducing or eliminating latent factors can prevent airway crises and improve patient safety. Nurse anesthesia trainees are at high risk for misdiagnosis and treatment of crises due to lack of non-technical skills.

### *Bronchospasm*

Bronchospasm is defined as “a reversible narrowing of the medium and small airways because of smooth muscle contraction” (Gaba et al., 2015, p. 184). Bronchospasm is considered an anesthesia airway crisis. Many factors predispose patients to a bronchospasm: asthma, chronic obstructive pulmonary disease, airway irritation, obesity, and/or medication side effects. The only way to prevent a bronchospasm during surgery would be to avoid anesthesia, especially with a high-risk patient undergoing elective surgery. However, avoiding anesthesia may not always be possible.

Nurse anesthesia trainees must be vigilant when monitoring for a bronchospasm. It is imperative to monitor changes in capnography waveforms that have an obstructive pattern and monitoring for desaturations in oxygenation. Auscultating the chest listening for decreased lung sounds or wheezing on exhalation will help with the differential diagnosis of a bronchospasm (Gaba et al., 2015).

Nurse anesthesia trainees have to prioritize a plan of action in order to treat a patient with a bronchospasm. These steps include ensuring adequate oxygen saturation and ventilation, verifying the diagnosis, increase anesthetic depth or administering a beta-2 agonist via the ventilator, and if the bronchospasm continues, instituting an intravenous bronchodilator and reassessing ventilation (Gaba et al., 2015). If nurse anesthesia students are not taught these non-technical skills, treatment may be delayed and harm to the patient can occur. Therefore, adequate non-technical skills are necessary in order to manage a potential airway crisis.

*Laryngospasm*

Laryngospasm is defined as “the sustained closure of the vocal cords resulting in the partial or complete loss of the patient’s airway” (Gavel & Walker, 2014, p. 47). The overall incidence occurring in anesthesia is 1% in the adult and pediatric populations (Gavel & Walker, 2014). Laryngospasm is usually triggered by mechanical (laryngeal or pharyngeal manipulation) or chemical stimuli (gastric contents). It is important to recognize high risk populations: pediatric patients less than five years old, excitement phase during anesthesia induction or emergence, light anesthesia relative to surgical stimulus, patient with recent upper respiratory infection in the last two weeks, and when mechanical irritants are in the airway including blood or secretions (Gaba et al., 2015).

Laryngospasm causes rapid deterioration in patients leading to hypoxia and bradycardia and if not recognized and treated appropriately, death can occur. Monitoring for lack of an end-tidal CO<sub>2</sub> waveform and inability to ventilate while providing positive pressure and assessing for audible stridor, tracheal tugging, retractions, inability to phonate, tachycardia, tachypnea, and cyanosis is imperative in the diagnosis of laryngospasm (Gaba et al., 2015). It is essential to recognize signs and symptoms of tongue or soft tissue obstruction and/or an improper facemask seal following extubation to rule out laryngospasm. According to Gaba et al. (2015), other differential diagnoses include intratracheal foreign bodies, infectious croup, subglottic hemangioma, vocal cord dysfunction, pharyngeal edema or abscess, and pneumothorax.

Prioritization is a key factor to decrease morbidity and mortality. The order of action to treat a laryngospasm is as follows: call for help, close the adjustable pressure limiting valve and apply 5-10 cm H<sub>2</sub>O continuous positive airway pressure with an FiO<sub>2</sub> of 100% using an anesthesia breathing circuit or bag valve mask, maximize efforts to open the airway with proper

technique including jaw thrust, head tilt, or oral airway, and administer medications such as propofol or succinylcholine to break the laryngospasm (Gaba et al., 2015). If these methods fail to break the laryngospasm, perform life saving airway measures with a cricothyrotomy or tracheostomy (Gaba et al., 2015).

Recognizing an airway crisis, performing a quick differential diagnosis, and prioritizing treatment for a laryngospasm are essential in order to prevent morbidity and mortality (Gavel & Walker, 2014). According to Gavel and Walker (2014) a laryngospasm is more likely to occur if the anesthesia provider is inexperienced. Therefore, training the nurse anesthesia trainee with the proper non-technical skills to treat a laryngospasm is necessary to ensure safe patient care.

### **Theoretical Framework**

The theoretical framework that guided this study was Clark and Paivio's Dual Coding Theory (Clark & Paivio, 1991). This theory explained the benefit of using multimedia teaching in nurse anesthesia education (Hartland, Biddle, & Fallacaro, 2008). The Dual Coding Theory revealed that language is processed in one area of the brain and imagery information in another, but these areas are intertwined and lead to dual coding of information. Hartland et al. (2008) used implied theory in their study, which demonstrated that patient safety vignettes allowed viewers to be immersed in a clinical scenario and led to a cognitive imprint. Hartland et al. (2008) also described that students learned by vicariousness and benefited from watching others mistakes and successes. These attributes of the Dual Coding Theory supported the use of instructional video simulation for teaching non-technical skills to nurse anesthesia trainees.

In summary, there is a gap in training non-technical skills to nurse anesthesia trainees during the didactic component. Once nurse anesthesia trainees are in their clinical residency and their patient has either bronchospasm or laryngospasm, there may be a delayed response to

recognize, make a decision, and treat the airway crisis. Literature supports the use of video simulation as a tool for incorporating didactic knowledge into clinical residency. Without proper non-technical skills instilled prior to the transition into clinical residency, nurse anesthesia trainees may lack the ability to manage airway crises successfully.

## **Methods**

### **Research Design**

A quasi-experimental pre-test and post-test study design was used to determine the efficacy of an instructional video simulation to improve non-technical skills knowledge for airway crisis management among second and third year nurse anesthesia trainees. This study took place on November 11<sup>th</sup>, 2017 following seminar club at NorthShore University HealthSystem (NSUHS) School of Nurse Anesthesia located in Evanston, Illinois. This project consisted of four phases. Phase 1: development of an instructional video that simulated the proper management of laryngospasm and bronchospasm and a knowledge assessment tool (KAT) that assessed non-technical skills knowledge pertaining to these airway crises. Phase 2: distribution of demographic information questionnaire and pre-test non-technical skills KAT of bronchospasm and laryngospasm management found in appendix C and D. Phase 3: implementation of an instructional video that simulated proper management of bronchospasm and laryngospasm crises with emphasis on the non-technical skills such as recognition, decision-making, and prioritization as seen in Appendix G. Lastly Phase 4: distribution of post-test non-technical skills KAT, which is the same test given in Phase 2 in order to reevaluate non-technical skills knowledge of study participants relevant to bronchospasm and laryngospasm management as seen in Appendix E.

### **Sample**

A convenience sample of second and third year nurse anesthesia trainees was recruited to participate in this study. These participants were from the NSUHS School of Nurse Anesthesia and had 0-10 months of clinical anesthesia experience. These nurse anesthesia trainees had a minimum degree of a Bachelor's of Science in Nursing and have a minimum of two years of nursing experience in an intensive care unit prior to matriculation into the nurse anesthesia program. First year trainees were excluded from this study because they had not yet received the didactic instruction on airway management.

### **Recruitment Process**

Emails of second and third year nurse anesthesia trainees on file at the NSUHS School of Nurse Anesthesia were used to recruit participants for this study and notify subjects of the research objectives. The Research Committee chair was the third party sender of the recruitment email that was sent out one week prior to the study (see Appendix A). This email consisted of an explanation of the purpose and subject matter of the study along with a request for participation (see Appendix B). Participants were informed about the purpose of the study, inclusion criteria, requirements of participation, and that their participation was voluntary and all information was to be kept confidential.

### **Ethical Considerations**

The researchers of this study completed Collaborative Institutional Training Initiative (CITI) training on April 1<sup>st</sup>, 2017 to ensure proper education regarding human subjects' protection and maintain ethical conduct of research. Prior to the study intervention, IRB approval from both NSUHS and DePaul University was obtained. The protection of human subjects was upheld throughout the research process. Participants were informed in the recruitment email, as well as prior to the study intervention, that their participation was voluntary

and they could choose to leave the study at any time. The recruitment email was sent out by a third party DNP project committee chair member to prevent researcher involvement. There were no personal identifiers or internet protocol addresses obtained from the participants.

### **Project Description**

#### *Phase 1: Non-Technical Skills Video KAT and Non-Technical Skills Instructional Video Script and Simulation Development*

A KAT was created to measure second and third year nurse anesthesia trainee's knowledge regarding recognition, decision-making, and prioritization during bronchospasm and laryngospasm airway crises. This tool was formulated using information from "*Crisis Management in Anesthesiology*" by Gaba et al. (2015) as well as an extensive review of relevant anesthesia textbook and current literature as described above. The non-technical skills KAT was submitted to a panel of five experts (faculty members of NSUHS School of Nurse Anesthesia) and revised until there was 100% approval to ensure content validity. This tool was then used as a pre-test and post-test to measure the effect of the video simulation intervention on knowledge acquisition of non-technical skills for airway crisis management.

Internal consistency of the investigator-developed non-technical skills KAT was measured using KR-20. KR-20 statistics approximates the reliability of the instrument measuring the attribute of knowledge as a binary outcome. The non-technical skills KAT produced incorrect answers (coded as 0) and correct answers (coded as 1).

After reviewing the literature and educational materials at the NSUHS School of Nurse Anesthesia, the researchers developed a script of an instructional video simulating the proper management of an airway crisis, specifically focusing on bronchospasm and laryngospasm. This script focused on the non-technical skills (recognition, decision-making, and prioritization)



needed to adequately manage airway crises, specifically bronchospasm and laryngospasm. Committee members Karen Kapanke, DNP, CRNA and Julia Feczko, DNP, CRNA reviewed this script for content validity and once committee approval was obtained, the same methods for obtaining content validity that were used in the development of the non-technical skills KAT were also used for obtaining content validity of the video script. The final script was included in IRB submission paperwork.

Following IRB approval, the instructional video simulation was filmed in an operating room at Evanston Hospital (part of NSUHS), in Evanston, IL. The video learning objectives included: identification of specific patient populations and clinical situations at risk for bronchospasm and laryngospasm, recognition of the clinical manifestations of bronchospasm and laryngospasm, and the proper steps in treating a bronchospasm and laryngospasm. After completion of the video, the instructional video simulation was submitted to Karen Kapanke, DNP, CRNA and Julia Feczko, DNP, CRNA for review. After final approval, the researchers proceeded with implementation.

*Phase 2: Distribution of Demographic Information Questionnaire and Pre-Test Non-Technical Skills KAT of Bronchospasm and Laryngospasm Management*

The pre-test non-technical skills KAT was distributed prior to viewing the intervention video. The test was placed in a manila envelope with no identifying information present. Second and third year nurse anesthesia trainees were asked to fill out the test labeled pre-test and they were allotted 10 minutes to fill out the demographic information questionnaire and pre-test. Once they both were completed, the researchers collected the envelopes and the study proceeded to Phase 3.

*Phase 3: Implementation of Non-Technical Skills Instructional Video Simulation*

Prior to the video, the researchers introduced the subject matter of the instructional video simulation and explained the purpose of the video. The video was 16 minutes in length and began with an educational piece discussing and listing specific patient populations at risk for bronchospasm. Next, a simulated bronchospasm clinical scenario was viewed. Standard anesthesia equipment displayed vital signs, capnography, and ventilator waveforms. Patient assessment data, such as chest movement and breath sound auscultation, was also shown. The video discussed which manifestations occurred during a bronchospasm and utilized close-up clips of vital signs, capnography and ventilator waveforms, chest movement, and breath sound auscultation. Next, a step-by-step demonstration of how to treat a bronchospasm was simulated. Following the bronchospasm scenario, a laryngospasm scenario followed in the same manner. Once the video simulation was completed, Phase 4 was implemented.

#### *Phase 4: Distribution of Post-Test Non-Technical Skills KAT*

Following the instructional video simulation, a post-test non-technical skills KAT was distributed. This post-test non-technical skills KAT was the same as the pre-test that was given to the nurse anesthesia trainees prior to viewing the video simulation. The post-test was placed into a manila envelope labeled post-test. Second and third year nurse anesthesia trainees were asked to complete the test and place their answers back into the manila envelope. Participants were allotted 10 minutes to complete the KAT, after which, the researchers collected the manila envelopes containing the completed KAT surveys.

#### **Data Collection**

Each participant was given two manila envelopes with a randomly assigned paired and coded number to ensure none of the information linked back to a particular participant. One envelope contained a demographic information questionnaire and pre-test non-technical skills

KAT. The second envelope contained a post-test non-technical skills KAT. The participants were asked to open the first manila envelope and complete the enclosed questionnaire and pre-test non-technical skills KAT within the 10-minute allotted time. After completion of the given tests, the participants placed them back into the first manila envelope provided and the researchers collected them. The 16-minute instructional video simulation was shown to the participants. Following the instructional video simulation, the participants were asked to open the second manila envelope and complete the enclosed post-test non-technical skills KAT. Participants had 10 minutes to complete the test, return it into the manila envelopment, and the researchers then collected the envelope. The pre and post-test non-technical skills KAT, demographic information questionnaire, and non-technical skills instructional video script can be found in the appendix section.

### **Analysis**

All data was analyzed using International Business Machines (IBM) Statistical Package for the Social Sciences (SPSS) version 22 (IBM, 2017). The demographic variables including age, years of critical care experience, and years of anesthesia training were grouped categorically and a Mann Whitney U Test was used to examine any association between demographic categorical grouping variables and non-technical skills scores. Because the data was not normally distributed, the Wilcoxon Signed Ranks Test was used to compare the median pre-test scores with the median post-test scores before and after watching the instructional video simulation. The Wilcoxon Signed Ranks Test is a non-parametric test used to test the null hypothesis that there is no difference in median scores for knowledge of non-technical skills involving recognition, decision-making, and prioritization during bronchospasm and

laryngospasm between pre and post-instructional video. A KR-20 test was used to determine reliability and show if there was discriminatory power in the pre and post-test questions.

### Results

A sample of 27 second and third year nurse anesthesia trainees participated and their data was used to determine the effect of an instructional video simulation on knowledge regarding recognition, decision-making, and prioritization during bronchospasm and laryngospasm airway crises. The participants' demographic data including age, years of critical care experience, and years of anesthesia training were reported (Table 1). Most of the participants were under 30 years old (55.6%: 15 out of 27), had 1-4 years of critical care experience (55.6%: 15 out of 27), and were second year nurse anesthesia trainees (66.7%: 18 out of 27).

The pre-test and post-test non-technical skills KAT that assessed the participants' knowledge regarding recognition, decision-making, and prioritization during bronchospasm and laryngospasm airway crises was coded appropriately as described above. The pre and post-test mean scores were obtained and the KR-20 test was used to determine the reliability of the KAT. The pre-test KAT (KR-20= 0.533) and the posttest KAT (KR-20= 0.686) were both found to have good reliability and showed a discriminatory power of the test questions (Table 2).

Because the data was not normally distributed, the non-parametric Wilcoxon Signed Ranks Test was used to test the null hypothesis that there is no difference in median scores for non-technical skills KAT during bronchospasm and laryngospasm crises between pre and post-instructional video. The mean scores for the pre-test was  $M=10.7407$  with a  $SD= 2.56594$  and a mean post-test score of  $M=15.8889$  with a  $SD= 1.68464$  as shown in Figure 1. The Wilcoxon Signed Ranks Test indicated that the median post-test scores were statistically significantly

higher than the median pre-test scores [ $Z = -4.473$ ;  $p = 0.000$  (2-tailed)]. These results are presented in Table 3.

To further evaluate the results of mean post-test scores, demographic data was analyzed to see if it had any contributing factors to the results using the Mann Whitney-U Test. The first demographic data analyzed was age (Table 4a). In the age group of 30 years old and younger, the mean post-test score was  $M = 13.33$  and in the age group of 31 years and older, the mean post-test score was  $M = 14.83$ . There was no significant effect of age grouping ( $U = 80$ ;  $Z = -0.531$ ;  $p = 0.595$ ). The null hypothesis was retained that the distribution of post-test mean scores is the same across categories of age groupings between 30 years and younger and 31 years and older.

The second demographic data analyzed was the number of years of critical care experience (Table 4b). For those participants with 1-4 years of critical care experience, the mean post-test score was  $M = 13.63$  and for those with 5 years or more of critical care experience, the mean post-test score was  $M = 14.46$ . There was no significant effect of groupings by the number of years of critical care experience ( $U = 84.5$ ;  $Z = -0.292$ ;  $p = 0.77$ ). The null hypothesis was retained that the distribution of post-test mean scores is the same across categories of years of critical care experience between those participants with 1-4 years of critical care experience and those with 5 years or more of critical care experience.

The third demographic data analyzed was the years of anesthesia training (Table 4c). Second year anesthesia trainees had a mean post-test score of  $M = 11.33$  and third year anesthesia trainees had a mean post-test score of  $M = 19.33$ . There was a significant effect of groupings by years of anesthesia trainees ( $U = 33$ ;  $Z = -2.68$ ;  $p = 0.007$ ). The null hypothesis was rejected. This study found a statistically significant difference in the distribution of the post-test mean scores between second and third year anesthesia trainees. This finding is also best illustrated in Figure

1, which showed consistently higher post-test mean scores among the third year nurse anesthesia trainees.

The specific non-technical skills (recognition, decision-making, and prioritization) were analyzed regarding the bronchospasm scenario (Table 5 and 6). Questions one and two of the non-technical skills KAT were related to recognition of bronchospasm. The mean pre-test score was  $M=1.7778$  with a  $SD=$  of 0.42366 and a post-test mean score of  $M=1.9259$  with a  $SD=$  0.26688. Questions three and four of the non-technical skills KAT were related to decision-making of bronchospasm. The mean pre-test score was  $M=1.1481$  with a  $SD=$  0.66238 and a post-test mean score of  $M=1.8148$  with a  $SD=$  0.39585. Questions five through nine of the non-technical skills KAT were related to prioritization. The mean pre-test score was  $M= 2.3704$  with a  $SD= 1.75736$  and a mean post-test score of  $M= 4.4815$  with a  $SD= 1.34079$ . The prioritization questions had an excellent pre-test KR- 20 of 0.737 and KR-20 post-test of 0.915, which showed participant mastery of the subject matter given the adequate reliability of the Prioritization Subscale of the KAT.

The specific non-technical skills (recognition, decision-making, and prioritization) were analyzed for the laryngospasm scenario (Table 5 and 6). Questions ten and eleven of the non-technical skills KAT were related to recognition of laryngospasm. The mean pre-test score was  $M=1.6296$  with a  $SD= 0.56488$  and the mean post-test score was  $M=1.7778$  with a  $SD=$  0.42366. Questions twelve and thirteen of the non-technical skills KAT were related to decision-making of laryngospasm. The mean pre-test score was  $M= 1.5926$  with a  $SD= 0.57239$  and the mean post-test score was  $M= 1.9630$  with a  $SD= 0.19245$ . Questions fourteen through seventeen of the non-technical skills KAT were related to prioritization. The mean pre-test score was  $M= 2.2222$  with a  $SD= 0.97402$  and the mean post-test score of  $M= 3.9259$  with a  $SD= 0.38490$ .

The prioritization questions had an excellent post-test KR- 20 score of 0.667, which showed good reliability of the Prioritization Subscale. The mean scores for pre-test in the Prioritization Subscales for Laryngospasm and Bronchospasm were  $M = 2.22$ ;  $SD = .974$  and  $M = 2.37$ ;  $SD = 1.75$ , respectively and the mean scores for post-test in Laryngospasm and Bronchospasm Subscales were  $M = 3.92$ ;  $SD = .384$  and  $M = 4.48$ ;  $SD = 1.34$ . The Wilcoxon Signed Ranks Test indicated that the median post-test scores were statistically significantly higher than the median pre-test scores for bronchospasm and laryngospasm, respectively [ $Z = -3.63$ ;  $p = 0.000$  (2-tailed);  $Z = -4.35$ ;  $p = .000$  (2-tailed)]. These subset analyses findings were consistent with the statistically significantly higher median post-test score than median pre-test score for the overall instructional video KAT questionnaire.

### **Discussion**

Bronchospasm and laryngospasm do not occur frequently in the practice setting which results in the anesthesia trainee having little to no exposure to these crises. Non-technical skills are necessary for proper management of these crises and must be demonstrated by the anesthesia provider to avoid medical errors and patient harm. Teaching non-technical skills is essential for the nurse anesthesia trainee transitioning into practice. Studies have supported the use of video simulation tools as an effective teaching method. By presenting an instructional video on the proper use of non-technical skills for the management of bronchospasm and laryngospasm, nurse anesthesia trainees were exposed to the proper methods of recognition, decision-making, and prioritization. To the researchers' knowledge, there are no other studies that test the effect of a video simulation tool on the proper recognition, decision-making, and prioritization during bronchospasm and laryngospasm airway crises.

During this study, second and third year nurse anesthesia trainees were shown an instructional video simulation demonstrating the proper non-technical skills of recognition, decision-making, and prioritization during the management of bronchospasm and laryngospasm airway crises. A Wilcoxon Signed Rank Test was used to determine that median post-test scores of a KAT significantly increased compared to pre-test scores after this instructional video simulation was introduced. Because the median score significantly increased [ $Z = -4.473$ ;  $p = 0.000$  (2-tailed)], this proved that the instructional video simulation improved knowledge of non-technical skills among nurse anesthesia trainees for the management of bronchospasm and laryngospasm airway crisis. This demonstrated that video simulation is an effective teaching method for non-technical skills instruction.

Participant demographics were analyzed to determine if they affected post-test results. Based on the different age groups ( $\leq 30$  years old and  $\geq 31$  years old), these two scores were not statistically different ( $p = 0.595$ ), which determined that age did not affect the ability to learn non-technical skills through video simulation. This finding was expected because these study participants, regardless of their age, have already displayed effective learning by completing a portion of a challenging anesthesia program. Most of the participants in this study were less than 30 years old. This generation is accustomed to the use of different types of technology being incorporated into teaching.

The number of years of critical care experience was also assessed. Based on the different number of years of critical care experience (1-4 year experience and  $\geq 5$  years experience), these two scores were not statistically significant ( $p = 0.77$ ). Therefore, the number of years of critical care experience did not affect the ability to learn non-technical skills through video simulation. This result was unexpected because non-technical skills may have been learned during critical



care nursing experience, giving those participants with more experience a learning advantage. However after further analysis, the specific non-technical skills used during bronchospasm and laryngospasm are not commonly utilized in critical care nursing and are more specific to anesthesia. Therefore, more critical care experience would not give those participants an advantage over those with less critical care experience.

The number of years of anesthesia training was also examined. Based on the different number of years of anesthesia training (second year nurse anesthesia trainees and third year anesthesia trainees), these results were statistically significant ( $p=0.007$ ). Therefore, the number of years of anesthesia training did affect the ability to learn non-technical skills through video simulation. This result was expected due to the higher likelihood of third year anesthesia trainees experiencing an airway crisis prior to this video simulation. Because second year anesthesia trainees did not have any clinical anesthesia experience, these non-technical skills may not have been as developed as they would be for third year anesthesia trainees. Third year anesthesia trainees that have been exposed to the anesthesia environment may have been more familiar with the elements taught in the instructional video simulation than second year anesthesia trainees with no clinical anesthesia exposure. This increased exposure may have giving third year anesthesia trainees a learning advantage.

The non-technical skills KAT results were reliable because the KR- 20 results were above 0.5 in the pre and post-test (0.533 and 0.686). These results demonstrated that the non-technical KAT had good validity and reliability and adequately measured non-technical skills knowledge among nurse anesthesia trainees. Ultimately, adequate KR-20 results strengthened the results of this study showing that instructional video simulation improved knowledge of non-

technical skills among nurse anesthesia trainees for the management of bronchospasm and laryngospasm airway crises.

### *Recognition*

Due to the fact that there were a limited number of questions assessing recognition of bronchospasm and laryngospasm, the KR- 20 score was not valid. The difference between pre-test and post-test mean scores for recognition could not be reliably analyzed. Although there was an increase in scores from bronchospasm pre-test to post-test (1.778, 1.9259) and laryngospasm pre-test to post-test (1.6296, 1.7778), the significance of this could not be validated. It was noted that post-test scores increased more after the bronchospasm scenario compared to the laryngospasm scenario. This may be due to anesthesia trainees having more prior exposure recognizing laryngospasm than bronchospasm. The research question that stated: did viewing an instructional video simulating the proper management of bronchospasm and laryngospasm improve the non-technical skill of *recognition* among nurse anesthesia trainees could not be answered completely. There was an improvement in the mean scores, however not to a reliable or statistically significant level.

### *Decision-Making*

Due to the fact that there were a limited number of questions assessing decision-making for bronchospasm and laryngospasm, the KR- 20 score was not valid. The difference between pre-test and post-test mean scores for decision-making could not be reliably analyzed. Although there was an increase in scores from bronchospasm pre-test to post-test (1.1481, 1.8148) and laryngospasm pre-test to post-test (1.5926, 1.9630), the significance of this could not be validated with the KR-20 test. It was also noted that post-test scores increased more after the bronchospasm scenario compared to the laryngospasm scenario. This may be due to anesthesia

trainees having more prior exposure creating a differential diagnosis for laryngospasm than bronchospasm. The research question that stated: did viewing an instructional video simulating the proper management of bronchospasm and laryngospasm improve the non-technical skill of *decision-making* among nurse anesthesia trainees could not be answered completely. There was an improvement in the mean scores, however not to a reliable or statistically significant level.

### *Prioritization*

Due to the increased number of questions used to assess prioritization for bronchospasm and laryngospasm the KR-20 determined good reliability and validity. The KR-20 score for bronchospasm pre-test (0.737) and post-test (0.915) indicated the nurse anesthesia trainees' mastery of the subject material. The KR-20 score for laryngospasm pre-test was unreliable, however the laryngospasm post-test score was 0.667, which was reliable. These KR-20 scores validated the sub-analysis results. The bronchospasm prioritization mean pre-test score was  $M=2.3704$  and a mean post-test score was  $M=4.4815$  and the laryngospasm prioritization mean pre-test score was  $M=2.2222$  and mean post-test score was  $M=3.9259$ . Both of these increases in scores were statistically significant [ $t=-5.366$ ;  $p=0.000$  (2-tailed)]; [ $t=-8.588$ ;  $p=0.000$  (2-tailed)]. It was also noted that mean post-test scores improved more for bronchospasm compared to laryngospasm. Again, this may be due to nurse anesthesia trainees having more exposure treating laryngospasm compared to bronchospasm. This indicated that an instructional video simulating the proper management of bronchospasm and laryngospasm improved the non-technical skill of prioritization among the nurse anesthesia trainees.

Ultimately, these findings showed that the use of an instructional video simulation improved knowledge of the non-technical skills during bronchospasm and laryngospasm among anesthesia trainees. Specifically, the instructional video simulation significantly improved

knowledge of prioritization among nurse anesthesia trainees. However, an increase in clinical anesthesia experience had an impact on non-technical skills knowledge.

### **Limitations**

The effectiveness of this instructional video simulation was assessed with a pre-test/post-test design and not actual patient care. However, the benefit of utilizing video simulation gave nurse anesthesia trainees the opportunity to gain non-technical skills in those crises that did not occur frequently during anesthesia training. The purpose of the video simulation was to educate nurse anesthesia trainees about airway crises that could occur in the operating room and improve knowledge of non-technical skills during bronchospasm and laryngospasm.

This study used a pre-test/post-test design. This type of study design could decrease internal validity because participants were exposed to a pre-test that could potentially affect post-test results. This research design format could lead to less definitive findings and create recall bias.

The study consisted of a small convenience sample of nurse anesthesia trainees from a single nurse anesthesia program. Having a small convenience sample decreased external validity and; therefore, results could not be generalized to other nurse anesthesia programs. If the sample size was larger, then the results might have been evenly distributed and could have reliably been generalizable.

In order to achieve a valid KR-20 score, a minimum of 4 questions need to be included in each KAT section. The recognition and decision-making sections of the KAT did not include at least 4 questions and therefore, created unreliable results. These two sections could have been strengthened by adding additional questions in order to improve the KR-20 score and create more reliable results.

### **Recommendations for Future Research**

The findings of this study demonstrated that instructional video simulation improved knowledge of the non-technical skills of recognition, decision-making, and prioritization during bronchospasm and laryngospasm among nurse anesthesia trainees. Further research could be used to strengthen and add to these findings. Revisiting another post-test a few weeks later to see if non-technical skills knowledge was retained could strengthen the study.

In the future, this study could be performed with a larger sample size and a control group. This would allow for randomization to increase generalizability. Also, repeated viewing of the video should be available and encouraged to allow for continued learning. Further research studies could also be designed to explore the use of instructional video simulation in additional areas of anesthesia crisis management. This could be a way to continue to close the learning gap between didactic and clinical practice.

### **Conclusion**

The findings of this study suggested that instructional video simulation improved knowledge of non-technical skills among nurse anesthesia trainees for the management of bronchospasm and laryngospasm airway crises. The effectiveness of the video is demonstrated by a Z-score of -4.473 [ $p=0.000$  (2-tailed)], which suggested that video simulation did improve non-technical skills knowledge in these specific airway crises. An adequate KR-20 score proved that the KAT used to measure increased knowledge of non-technical skills provided reliable results. The improvement in median test scores between the pre and post-instructional video KAT demonstrated that nurse anesthesia trainees obtained knowledge of non-technical skills (recognition, decision-making, prioritization) during the simulation of bronchospasm and laryngospasm.

However, when looking specifically at recognition and decision-making, the KR-20 scores for these subgroups were not adequate. Although there was an increase in median scores, it could not be determined if the instructional video simulation reliably and significantly increased non-technical skills knowledge in these areas. Due to an adequate KR-20 score, prioritization for bronchospasm and laryngospasm could be reliably analyzed. Post-test scores following the instructional video simulation significantly increased for both bronchospasm and laryngospasm [ $t=-5.366$ ;  $p=0.000$  (2-tailed)]; [ $t=-8.588$ ;  $p=0.000$  (2-tailed)]. These increase in scores indicated that an instructional video simulating the proper management of bronchospasm and laryngospasm improved, specifically the non-technical skill of prioritization, among the nurse anesthesia trainees.

This teaching technique proved to be a beneficial learning tool for nurse anesthesia trainees. An instructional video simulation did improve non-technical skills, specifically prioritization, for bronchospasm and laryngospasm among nurse anesthesia trainees. These findings demonstrated that an instructional video could be used as an adjunct in the didactic portion of the nurse anesthesia curriculum.

**Appendix A.****Recruitment Email**

Dear fellow NATs,

On November 11<sup>th</sup>, you are being asked to participate in a research study we are conducting as part of our DNP project. For the research, you will be asked to attend a seminar that provides an educational video simulation. The goal of this seminar is to determine if a video simulation will improve your level of knowledge in recognition, decision-making, and prioritization during an airway crisis. You will be asked to complete surveys: two prior to the video and one after. The first survey is based on your years of critical care experience, highest level of education, anesthesia year of training, age, sex and race. The second and third surveys will include a brief test of your prior knowledge of non-technical skills during an airway crisis before watching the instructional video simulation and after. All of these surveys will be completely anonymous. If there are questions you prefer not to answer, you may skip it. This educational video will take approximately 10 minutes of your time. You will be allotted 10 minutes to complete each of the pre and post-video surveys.

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

Sincerely,

Laurie McLaughlin, RN and Katie Walus, RN

## Appendix B.

### **Information Sheet for Participation in Research Study Use of Non-Technical Skills Training & Video Simulation to Improve Knowledge Among Nurse Anesthesia Trainees**

**Principal Investigator:** Laurie McLaughlin, RN; Kathryn Walus, RN

**Institution:** DePaul University, Chicago, IL.

**Collaborators:** NorthShore University HealthSystem School of Nurse Anesthesia: Karen Kapanke, DNP, CRNA and Julia Feczko, DNP, CRNA

We are conducting a research study because we are aiming to learn more about use of non-technical skills and a video simulation to improve knowledge during an airway crisis. We are asking you to be in the research because you are enrolled in the NorthShore University HealthSystem School of Nurse Anesthesia and are in your second or third year of training. If you agree to be in this study, you will be asked to watch a 10-minute educational video on non-technical skills (recognition, decision-making, and prioritization) of bronchospasm and laryngospasm. You will be asked to complete paper surveys with pen or pencil, one prior to watching the video and one after. The surveys will include questions about your perceived knowledge assessment in non-technical skills during an airway crisis. We will also collect some personal information about your years of critical care experience, highest level of education, anesthesia year of training, age, sex, and race. If there are questions you would prefer not to answer, you may skip it.

Your participation is completely voluntary, which means you can choose not to participate. By attending the video session and submitting the surveys, we will assume that you are agreeing to be in the research. There will be no negative consequences if you decide not to participate or change your mind prior to turning in the initial survey. You can withdraw your participation at any time prior to submitting your initial survey. If you change your mind later



while answering the survey, you may stop answering the survey and exit the room. The survey will then be disposed of in a way to maintain confidentiality. Once you submit your responses, we will be unable to remove your data given that it is anonymous. Your decision whether or not to be in the research will not affect any grade, evaluation, or status within DePaul University or NorthShore University HealthSystem School of Nurse Anesthesia.

If you have questions, concerns, or complaints about this study or you would like to get additional information or provide input about this research, please contact Laurie McLaughlin at [lauriebailey85@gmail.com](mailto:lauriebailey85@gmail.com) or Katie Walus at [Kwalus421@gmail.com](mailto:Kwalus421@gmail.com). If you have questions about your rights as a research subject you may contact Susan Loess-Perez, DePaul University's Director of Research Compliance, in the Office of Research Services at 312-362-7593 or by email [sloesspe@depaul.edu](mailto:sloesspe@depaul.edu). You may also contact DePaul's Office of Research Services if:

- The research team is not answering your questions, concerns, or complaints.
- You cannot reach the research team.
- You want to talk to someone besides the research team.

You may keep (or print) this form for your records.

### Appendix C.

#### Demographic Information Questionnaire

1. Age group	<input type="checkbox"/> 1 <25 years old <input type="checkbox"/> 2 26-30 <input type="checkbox"/> 3 31-35 <input type="checkbox"/> 4 36-40 <input type="checkbox"/> 5 >41 years old
2. Race	<input type="checkbox"/> 1 Caucasian <input type="checkbox"/> 2 Hispanic or Latino <input type="checkbox"/> 3 Black or African American <input type="checkbox"/> 4 Native American or American Indian <input type="checkbox"/> 5 Asian/Pacific Islander <input type="checkbox"/> 6 Other
3. Sex	<input type="checkbox"/> 1 Male <input type="checkbox"/> 2 Female
4. Prior to anesthesia school, how many years of critical care experience did you have?	<input type="checkbox"/> 1 1-2 years <input type="checkbox"/> 2 3-4 years <input type="checkbox"/> 3 5-6 years <input type="checkbox"/> 4 7-8 years <input type="checkbox"/> 5 >9 years
5. Prior to anesthesia school, what was your highest level of education?	<input type="checkbox"/> 1 Associates degree <input type="checkbox"/> 2 Bachelors degree <input type="checkbox"/> 3 Masters degree <input type="checkbox"/> 4 Doctorate degree (DNP/PhD)
6. At what point of anesthesia training are you in at this time?	<input type="checkbox"/> 1 First Year NAT <input type="checkbox"/> 2 Second Year NAT <input type="checkbox"/> 3 Third Year NAT

## Appendix D.

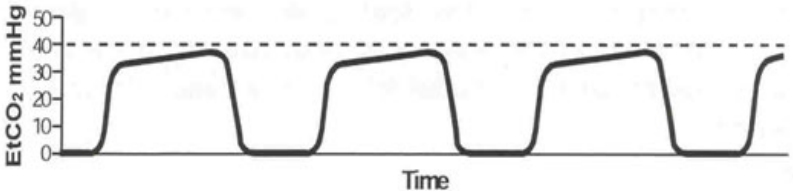
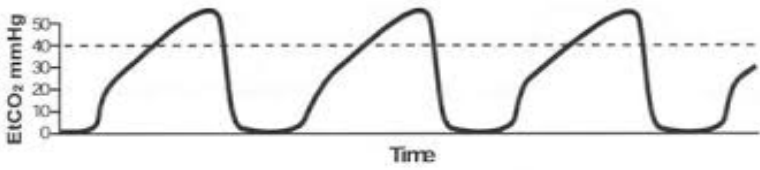
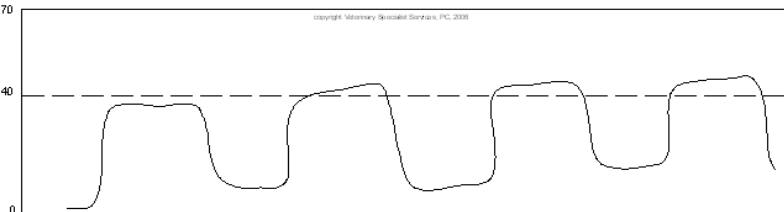
### PRE-VIDEO NON-TECHNICAL SKILLS KNOWLEDGE ASSESSMENT TOOL

Please complete the following questions as they relate to recognition, decision-making, and prioritization of bronchospasm and laryngospasm. This survey is voluntary and anonymous. Completion of this survey should take approximately 10 minutes.

#### Pre-Video Test

#### *Bronchospasm*

#### *Recognition*

- Which of the following diseases states or patient populations are at increased risk for bronchospasm? **(CHOOSE 3)**
  - Patients > 65 years old
  - Asthma
  - Smoker
  - Obstructive sleep apnea
  - Recent upper respiratory tract infection
- Which capnography waveform would you notice during a bronchospasm?
  - 
  - 
  - 

*Decision-Making*

3. The intubated patient's peak airway pressures alarm at 45 cm H<sub>2</sub>O. What are possible differential diagnoses? (**CHOOSE 3**)
  - A. Bronchospasm
  - B. The ETT has migrated right mainstem
  - C. The ETT may be kinked
  - D. The ETCO<sub>2</sub> line may be kinked
  - E. A pulmonary or venous air embolism has just occurred
  
4. Which of the following assessment criteria would help confirm a diagnosis of a bronchospasm?
  - A. BP 90/50, O<sub>2</sub> Sat 89%, audible wheezing on inhalation
  - B. BP 90/50, O<sub>2</sub> Sat 89%, audible wheezing on exhalation
  - C. BP 150/90, O<sub>2</sub> Sat 90%, breath sounds on the right and absent on the left
  - D. BP 80/55, O<sub>2</sub> Sat 95%, breath sounds clear bilaterally

*Prioritization*

List in order which actions you would take if you suspected a bronchospasm in an intubated patient

5. \_\_\_\_\_ A. Auscultate chest to check ETT placement and patency
6. \_\_\_\_\_ B. Administer IV bronchodilator (epinephrine)
7. \_\_\_\_\_ C. Administer inhalational bronchodilator (increase volatile agent if not hypotensive and give 4-8 puffs of albuterol)
8. \_\_\_\_\_ D. Increase FiO<sub>2</sub> to 100% and manually ventilate patient
9. \_\_\_\_\_ E. Decrease tidal volumes, increase respiratory rate, and change I:E Ratio to 1:3

*Laryngospasm**Recognition*

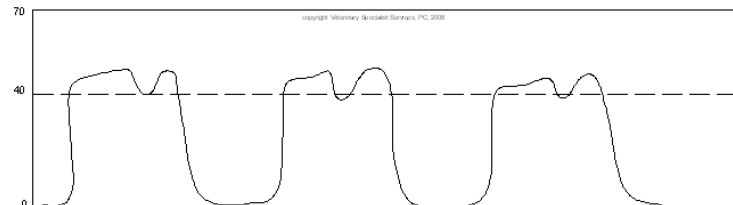
10. Which typical situations or patient populations can put a patient at risk for laryngospasm?

**(CHOOSE 3)**

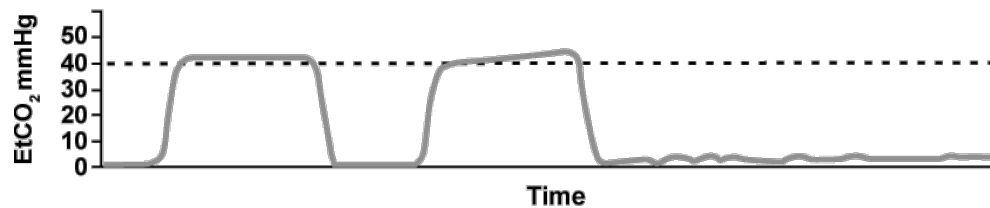
- A. Excitement phase during an anesthetic induction or emergence
- B. History of sleep apnea
- C. Anesthetized patient with an endotracheal tube in place
- D. Pediatric patient less than 5 years old
- E. Blood or secretions in the airway

11. Which capnography waveform would you notice during a laryngospasm?

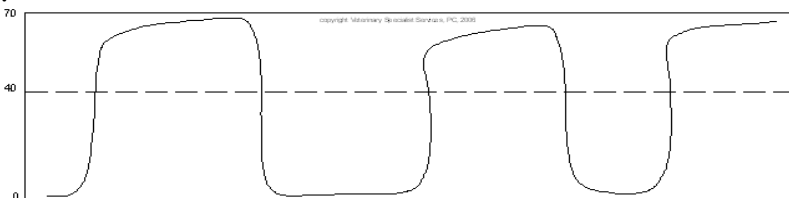
A.



B.



C.

*Decision-Making*

12. The extubated patient's end-tidal CO<sub>2</sub> alarms at 0 mmHg. What are possible differential diagnoses? **(CHOOSE 3)**

- A. Laryngospasm
- B. Shallow breaths taken due to too much narcotic administration
- C. Tongue or soft tissue obstruction following extubation
- D. Poor mask seal following extubation

13. Which of the following assessment criteria would help confirm a diagnosis of a laryngospasm?
- A. HR 115, O<sub>2</sub> Sat 80%, respiration improvement after proper oral airway insertion
  - B. HR 50, O<sub>2</sub> Sat 70%, tracheal tugging and audible stridor
  - C. HR 90, O<sub>2</sub> Sat 85%, tidal volume 150 and respiratory rate of 6
  - D. HR 80, O<sub>2</sub> Sat 93%, end-tidal CO<sub>2</sub> increases to 45 mm hg after sitting the head of bed up

*Prioritization*

List in order which actions you would take if you suspected a laryngospasm in your patient

- 14. \_\_\_ A. Administer IV/IM medications (ie propofol, succinylcholine, or rocuronium)
- 15. \_\_\_ B. Use maximum efforts to open the airway (jaw thrust, Larson maneuver, head tilt, oral or nasal airway)
- 16. \_\_\_ C. Call for help
- 17. \_\_\_ D. Institute at least 5-10 cm H<sub>2</sub>O with an FiO<sub>2</sub> of 100% using an anesthesia breathing circuit or bag valve mask

## Appendix E.


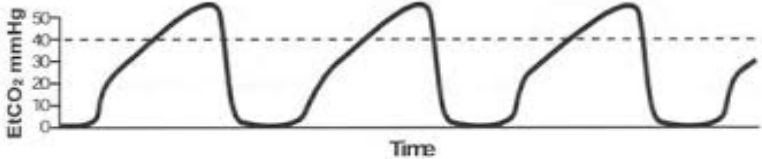
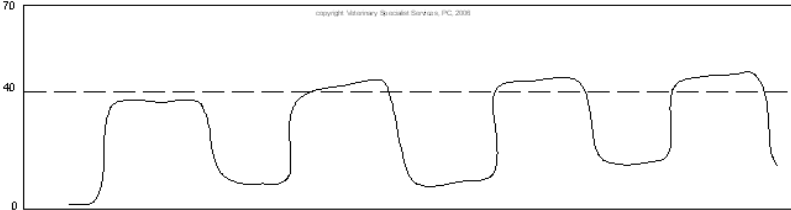
### POST-VIDEO NON-TECHNICAL SKILLS KNOWLEDGE ASSESSMENT TOOL

Please complete the following questions as they relate to recognition, decision-making, and prioritization of bronchospasm and laryngospasm. This survey is voluntary and anonymous. Completion of this survey should take approximately 10 minutes.

#### Post-Video Test

##### *Bronchospasm*

##### *Recognition*

- Which of the following diseases states or patient populations are at increased risk for bronchospasm? **(CHOOSE 3)**
  - Patients > 65 years old
  - Asthma
  - Smoker
  - Obstructive sleep apnea
  - Recent upper respiratory tract infection
- Which capnography waveform would you notice during a bronchospasm?
  - 
  - 
  - 

*Decision-Making*

3. The intubated patient's peak airway pressures alarm at 45 cm H<sub>2</sub>O. What are possible differential diagnoses? (**CHOOSE 3**)
  - A. Bronchospasm
  - B. The ETT has migrated right mainstem
  - C. The ETT may be kinked
  - D. The ETCO<sub>2</sub> line may be kinked
  - E. A pulmonary or venous air embolism has just occurred
  
4. Which of the following assessment criteria would help confirm a diagnosis of a bronchospasm?
  - A. BP 90/50, O<sub>2</sub> Sat 89%, audible wheezing on inhalation
  - B. BP 90/50, O<sub>2</sub> Sat 89%, audible wheezing on exhalation
  - C. BP 150/90, O<sub>2</sub> Sat 90%, breath sounds on the right and absent on the left
  - D. BP 80/55, O<sub>2</sub> Sat 95%, breath sounds clear bilaterally

*Prioritization*

List in order which actions you would take if you suspected a bronchospasm in an intubated patient

5. \_\_\_ A. Auscultate chest to check ETT placement and patency
6. \_\_\_ B. Administer IV bronchodilator (epinephrine)
7. \_\_\_ C. Administer inhalational bronchodilator (increase volatile agent if not hypotensive and give 4-8 puffs of albuterol)
8. \_\_\_ D. Increase FiO<sub>2</sub> to 100% and manually ventilate patient
9. \_\_\_ E. Decrease tidal volumes, increase respiratory rate, and change I:E Ratio to 1:3



*Laryngospasm*

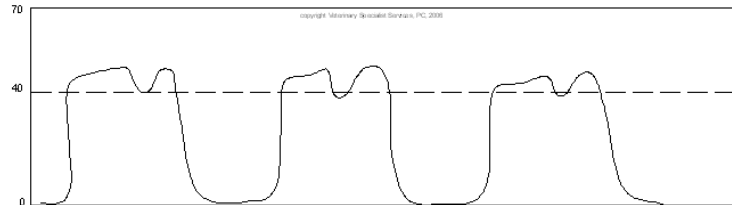
*Recognition*

10. Which typical situations or patient populations can put a patient at risk for laryngospasm?  
**(CHOOSE 3)**

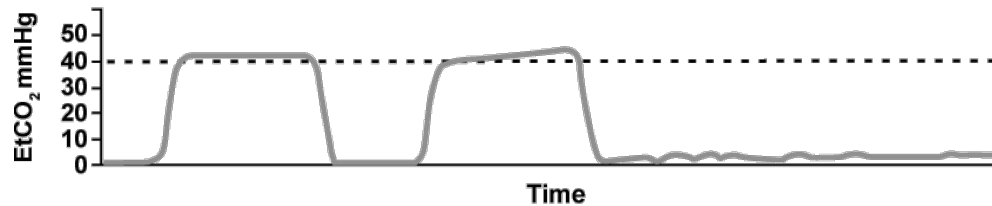
- A. Excitement phase during an anesthetic induction or emergence
- B. History of sleep apnea
- C. Anesthetized patient with an endotracheal tube in place
- D. Pediatric patient less than 5 years old
- E. Blood or secretions in the airway

11. Which capnography waveform would you notice during a laryngospasm?

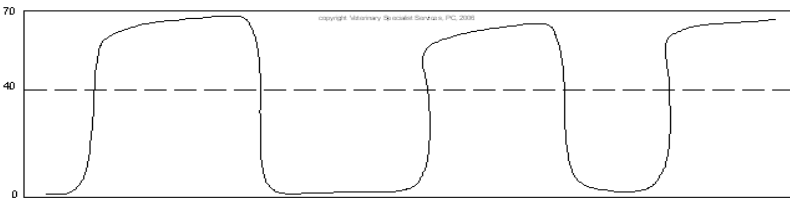
A.



B.



C.



*Decision-Making*

12. The extubated patient's end-tidal CO<sub>2</sub> alarms at 0 mmHg. What are possible differential diagnoses? **(CHOOSE 3)**

- A. Laryngospasm
- B. Shallow breaths taken due to too much narcotic administration
- C. Tongue or soft tissue obstruction following extubation
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13. Which of the following assessment criteria would help confirm a diagnosis of a laryngospasm?
- A. HR 115, O<sub>2</sub> Sat 80%, respiration improvement after proper oral airway insertion
  - B. HR 50, O<sub>2</sub> Sat 70%, tracheal tugging and audible stridor
  - C. HR 90, O<sub>2</sub> Sat 85%, tidal volume 150 and respiratory rate of 6
  - D. HR 80, O<sub>2</sub> Sat 93%, end-tidal CO<sub>2</sub> increases to 45 mmHg after sitting the head of bed up

*Prioritization*

List in order which actions you would take if you suspected a laryngospasm in your patient

- 14. \_\_\_\_ A. Administer IV/IM medications (ie propofol, succinylcholine, or rocuronium)
- 15. \_\_\_\_ B. Use maximum efforts to open the airway (jaw thrust, Larson maneuver, head tilt, oral or nasal airway)
- 16. \_\_\_\_ C. Call for help
- 17. \_\_\_\_ D. Institute at least 5-10 cm H<sub>2</sub>O with an FiO<sub>2</sub> of 100% using an anesthesia breathing circuit or bag valve mask

**Appendix F.****ANSWER KEY  
Pre and Post-Video Survey**

Answer Key:

**Bronchospasm**

1. B, C, E
2. B
3. A, B, C
4. B
5. D
6. A
7. C
8. B
9. E

**Laryngospasm**

10. A, D, E
11. B
12. A, C, D
13. B
14. C
15. D
16. B
17. A

**Appendix G.**  
**Non-Technical Skills Instructional Video Script**  
**(Bronchospasm and Laryngospasm)**

**Instructional Video Script for Recognition, Decision-making and Prioritization During**  
**Bronchospasm and Laryngospasm**

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

**VIDEO CONTENT AND SCRIPT**

**Screen 1: Introduction**                      **Use of Non-Technical Skills Training & Video Simulation to Improve Knowledge Among Nurse Anesthesia Trainees**

**By: Laurie McLaughlin and Kathryn Walus**

**Screen 2:**                      **Teaching Objectives**

Following this instructional video, the nurse anesthesia trainee will be able to:

1. Recognize the occurrence of bronchospasm and laryngospasm
2. Formulate differential diagnoses to improve decision-making skills
3. Prioritize the correct sequence of steps for treating bronchospasm and laryngospasm

**Screen 3:**                      (Slide displaying a picture of the four non-technical skills and their subset of elements)  
 Voice over: *Non-technical skills are the cognitive and interpersonal skills that complement an individual's clinical knowledge and facilitate the effective delivery of safe care. A classification system called the Anesthetists' non-technical skills or ANTS was developed to describe the non-technical skills most crucial to safe anesthesia practice. These include situational awareness, decision-making, task-management, and teamwork. This instructional video will focus on recognition, decision-making, and prioritization, which are specific elements of 3 out of the 4 non-technical skills. The scenarios of bronchospasm and laryngospasm will be used to illustrate these non-technical skills.*

**Screen 4:**                      **Bronchospasm**

Voice over: *During the perioperative period, it is important for the anesthesia provider to recognize the comorbidities and clinical situations that can predispose a patient to bronchospasm (read through list)*

**Typical Comorbidities and Clinical Situations**  
**Associated with Bronchospasm**

- Patients with asthma, COPD, or recent URI
- Smokers
- Airway manipulation (placement of oral, supraglottic, or endotracheal tube; endobronchial intubation)
- Pungent anesthetic gases (ie: Desflurane)

- Light plane of anesthesia
- Non-selective beta2-antagonists (ie: labetalol)
- Anticholinesterases
- Drug allergies
- Aspiration
- PE

**Screen 5:** Voice over: *The following scenario will be used to display the proper recognition, decision-making, and prioritization during bronchospasm. Mr. Jackson is a 30-year-old 100kg male undergoing a tonsillectomy and adenoidectomy. He has a history of smoking a pack a day for 10 years and asthma. This patient was just induced and an endotracheal tube was placed. Sevoflurane is being used and is currently at 0.5 MAC. The table has been turned 90 degrees and surgeon has just placed a shoulder roll and is inserting the jaw retractor*

**Patient Info:** 30 year old male, 100 kg

**Procedure:** T&A

**History:** 10 pack year smoker and asthma

**Anesthetic type:** General Anesthesia Endotracheal Tube (GETA) with sevoflurane

**Other:** After induction, the surgeon is placing shoulder roll and jaw retractor; sevoflurane is at 0.5 MAC

**Screen 6:**  
**Split screen will show reenactment of the clinical scenario while also displaying the monitoring devices**

**Clinical Scenario Video**

Surgeon: *Now that we've completed the time out, I'll get started. Scalpel please. (close up of 0.5 MAC shown on split screen)*

Anesthesia provider: *(Peak airway pressure alarming in the background with decreasing pitch in the oxygen saturation and increasing frequency of heart rate) No we are not ready yet. The patient's peak airway pressures are unusually high and vital signs are unstable.*

Video is paused and capnography, peak inspiratory pressure monitors, and vital signs are displayed. Peak inspiratory pressure is 45 cm H<sub>2</sub>O, capnography showing a change from a normal waveform to an upward sloping waveform, O<sub>2</sub> saturation of 89%, BP 90/50, and HR 115 BPM (on split screen)

Voice over: *During the recognition process, the anesthesia provider identifies that there is a possible bronchospasm based on high peak inspiratory pressures, an upward sloping capnograph waveform, and recognizing the patient is at risk for bronchospasm based on a history of smoking and asthma, light anesthesia, and the surgeon manipulating the airway.*

*During the decision making process, the anesthesia provider must rule out differential diagnoses. During bronchospasm, the anesthesia provider would expect increased peak inspiratory pressures, upward sloping of capnograph waveform, decreased O<sub>2</sub> saturation, hypotension, and expiratory wheezing. A right mainstem endotracheal tube can also produce high peak inspiratory*

*pressures and desaturation. However, the anesthesia provider would expect to hear unilateral right-sided breath sounds. A kinked endotracheal tube would also cause high peak inspiratory pressure and desaturation so visually examining the endotracheal tube for kinks is an important step.*

### **Differential Diagnoses**

(Shown on split screen)

- **Bronchospasm-** Increased peak inspiratory pressures, upward sloping capnograph waveform, decreased oxygen saturation, decreased blood pressure, and expiratory wheezing
- **Right mainstem-** Inc. peak inspiratory pressures, Dec. O<sub>2</sub> sat, unilateral right-sided breath sounds.
- **Kinked ETT-** Inc. peak inspiratory pressures, Dec. O<sub>2</sub> sat, determined by visual inspection

**Screen 7:** *The prioritization of the anesthetist's actions for bronchospasm is as follows: first, the FiO<sub>2</sub> is changed to 100% and the patient is manually ventilated to assess the compliance of the lungs while the anesthetist calls for help.*

**Split screen will show reenactment of clinical scenario while also displaying prioritization steps**

Split screen shows a close up of this action

*Second, the verification of bronchospasm must be made by auscultating the chest and simultaneously checking the endotracheal tube for kinks.*

Split screen shows a close up of this action

*Third, after a bronchospasm has been verified, an inhalational bronchodilator can be administered. Increasing sevoflurane is done if the patient is not hypotensive to promote bronchodilation and increase anesthetic depth. Next, 4-8 puffs a beta 2 agonist is administered, such as albuterol, to promote bronchodilation.*

Split screen shows a close up of this action

*Fourth, if the bronchospasm has not yet broken, an intravenous bronchodilator is given, such as epinephrine 0.1mcg/kg bolus.*

Split screen shows a close up of this action

*Fifth, the ventilator settings are adjusted to decrease the peak inspiratory pressure and prevent barotrauma by decreasing the tidal volume and increasing respiratory rate. The I:E ratio is changed to 1:3 to allow for prolonged expiration to prevent hyperinflation or auto-PEEP*

Split screen shows a close up of this action

### **Prioritization of Actions for Bronchospasm**

(displayed on split screen while other screen shows close up of each action)

1. Increase FiO<sub>2</sub> to 100%, manually bag patient, and call for help
2. Auscultate chest to check ETT placement and patency
3. Administer inhalational bronchodilator (increase volatile agent if not hypotensive and give 4-8 puffs of albuterol)
4. Administer IV bronchodilator (0.1mcg/kg bolus of Epinephrine)
5. Decrease tidal volumes, increase respiratory rate, and change I:E ratio to 1:3

**Screen 8:**  
**Split screen**  
**will show**  
**reenactment**  
**of the clinical**  
**scenario**  
**while also**  
**displaying**  
**the**  
**monitoring**  
**devices**

Voice over: *Using the decision making and prioritization skills just described, the patient's bronchospasm can be managed in real time as follows.*

Video is unpaused, and the capnography, peak inspiratory pressure monitors and vital signs are displayed. Peak inspiratory pressure is 45 cm H<sub>2</sub>O, capnograph showing an upward sloping waveform, O<sub>2</sub> saturation of 89%, BP 90/50, and HR 115 BPM (on split screen)

Anesthesia provider: *I am going to turn the FiO<sub>2</sub> to 100% and manually bag the patient.*

*The lungs feel less compliant and it is difficult to move air*

*I am going to listen to breath sounds*

*(expiratory wheezing sounds play in the background over right and left lung fields). The patient has expiratory wheezing bilaterally so I can rule out a right mainstem endotracheal tube.*

*(inspection of endotracheal tube) The endotracheal tube is not kinked, so I can also rule this out. I am suspecting the patient is in bronchospasm. I am going to increase the gas only slightly because the blood pressure is 90/55. Laurie, can you hand me albuterol and a 60cc syringe?*

*(Laurie hands Katie the albuterol and a 60cc syringe)*

*Laurie: Here is albuterol and a 60cc syringe*

**Screen 9:** *Voice Over: Ideally, albuterol should be administered through an aerosolizer; however, in a crisis situation or if an aerosolizer is not available, a 60cc syringe can be used as follows."*

Close up shown of anesthesia provider placing albuterol into 60cc syringe and administering 4-8 puffs down the endotracheal tube and then ventilating the patient.

**Screen 10:**  
**Split screen**  
**will show**  
**reenactment**

The clinical scenario and split screen are shown

The same vital signs persist after giving the albuterol (shown in split screen)

Anesthesia provider: *The inhalational bronchodilators are not working. I need*

**of the clinical scenario while also displaying the monitoring devices** *to administer an IV bronchodilator. Laurie will you hand me a syringe of double diluted epinephrine; 10mcg/ml?*

Laurie: *Here is epinephrine with a concentration of 10mcg/cc*

Anesthesia provider: *Ok I am going to give 0.1mcg/kg for this 100kg patient, which is 10mcg or 1cc*

Anesthesia provider administer IV epinephrine

Anesthesia provider: *I am going to put the patient back on the ventilator, lower the tidal volumes to 400ml and increase the respiration rate to 18 breaths per minute. I am also going to change the I:E ratio from 1:2 to 1:3*

Capnograph waveform returns to normal, peak inspiratory pressures fall to 20 cm H<sub>2</sub>O, O<sub>2</sub> saturation increases to 97%, blood pressure increases to 120/80, and heart rate is 117. (displayed on split screen)

Anesthesia provider: *Ok, it looks like the bronchospasm has resolved*

**Screen 11:****Laryngospasm**

Voice over: *We will now use the scenario of laryngospasm to solidify the skills of recognition, prioritization, and decision-making. Lets begin with recognition. The following disease processes, patient populations, and clinical situations can predispose a patient to laryngospasm (read through list)*

**Typical Disease Process, Patient Populations, and Clinical Situations  
Associated with Laryngospasm**

- During the excitement phase of induction or emergence
- Light anesthesia relative to surgical stimulus
- Blood or secretions in the airway
- Airway instrumentation
- Airway surgical procedures
- Patients with GERD
- Patients with recent upper respiratory infection in the last 2 weeks
- Young age (<5 years)

**Screen 12:**

Voice over: *The following scenario will be used to display the proper recognition, decision-making, and prioritization during laryngospasm (read clinical scenario)*

Mr. Jackson is now at the end of his tonsillectomy and adenoidectomy procedure. He is emerging from anesthesia and is getting ready to be extubated. He has an oral airway in place. The surgeon states that he does not want any suctioning in the airway to ensure the surgical site is not manipulated. The anesthesia provider does not want any coughing during emergence, so the endotracheal tube is taken out with an end-tidal of 0.4 sevoflurane.



<b>Screen 13: Split screen will show reenactment of the clinical scenario while also displaying the monitoring devices</b>	<p><b><u>Clinical Scenario Video</u></b> Anesthesia provider: <i>Ok Mr. Jackson your surgery is over (anesthesia provider placing mask over patient's face). Mr. Jackson take some nice deep breaths.</i></p> <p>Video is paused and capnograph, end tidal carbon dioxide, and vital signs are displayed. The capnograph shows a change from a normal waveform to a flat waveform, end tidal carbon dioxide reads 0 mmHg, O<sub>2</sub> saturation of 70%, BP 80/40, and HR 50 BPM (on split screen)</p> <p>Voice over: <i>During the recognition process, the anesthesia provider identifies that there is a possible laryngospasm based on an end tidal carbon dioxide of 0 mmHg, a flattened capnograph waveform, and recognizing the patient is at risk for laryngospasm based on this being an airway surgery, the possibility of blood or secretions in the back of the airway due to not suctioning, and the possibility of the patient being in the excitement phase of emergence when the endotracheal tube was removed.</i></p>
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*During the decision-making process, the anesthesia provider must rule out differential diagnoses. During laryngospasm, the anesthesia provider would expect a loss of end tidal carbon dioxide, inability to mask ventilate, stridor if the vocal cords are not completely closed, tracheal tugging, decreased O<sub>2</sub> saturation, and tachycardia or bradycardia. A lack of a proper seal on the facemask can also cause a loss of end tidal carbon dioxide. However, readjustment of the mask, visible chest rise, and adequate O<sub>2</sub> saturation should rule this out. Tongue or soft tissue obstruction can also cause loss of end tidal carbon dioxide, difficulty with mask ventilation, tracheal tugging and decreased O<sub>2</sub> saturation. However, stridor is not present with soft tissue obstruction and this patient has an oral airway in place that would make this unlikely.*

#### **Differential Diagnoses**

(shown on split screen)

- **Laryngospasm-** loss of ETCO<sub>2</sub>, inability to mask ventilate, stridor (if cords are not completely closed), tracheal tugging, Dec. O<sub>2</sub> sat, tachycardia or bradycardia
- **Poor seal on facemask-** loss of ETCO<sub>2</sub>, adequate oxygen saturation, visible chest rise, ETCO<sub>2</sub> returns with proper mask seal
- **Tongue/soft tissue obstruction-** loss of ETCO<sub>2</sub>, difficult mask ventilation, tracheal tugging, decreased oxygen saturation, no stridor, oral airway improves ventilation

<b>Screen 14: Split screen will show reenactment of clinical scenario</b>	<p><i>The prioritization of the anesthetist's actions for laryngospasm is as follows: first, call for help.</i></p> <p>Split screen shows a close up of this action</p> <p><i>Second, institute at least 5-10 cmH<sub>2</sub>O with an FiO<sub>2</sub> of 100% using an</i></p>
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**while also displaying prioritization steps**     *anesthesia breathing circuit or bag valve mask. This can be done on an anesthesia circuit by closing the APL valve to 5-10 cmH20 and letting the patient breath or administering breaths (most providers close APL valve to 30-40 cmH20).*

Split screen shows a close up of this action

*Third, use maximum efforts to open the airway, such as a jaw thrust, head tilt, and insertion of an oral or nasal airway.*

Split screen shows a close up of this action

*Fourth, administer IV or IM medications. Propofol 1mg/kg can be used to deepen anesthesia or succinylcholine 0.5-2mg/kg IV can be used to relax the vocal cords.*

Split screen shows a close up of this action

#### **Prioritization of Actions for Laryngospasm**

(displayed on split screen while other screen shows close up of each action)

1. Call for help
2. Institute at least 5-10cm H20 with and FiO2 of 100% using an anesthesia breathing circuit or bag valve mask
3. Use maximum efforts to open the airway (jaw thrust, head tilt, oral or nasal airway)
4. Administer IV/IM medications (ie propofol, succinylcholine, or rocuronium)

**Screen 15:**     *Voice over: Using the decision making and prioritization skills just described, the patient's laryngospasm can be managed in real time as follows.*  
Video is unpaused and the capnograph, end tidal carbon dioxide, and vital signs are displayed. The capnograph shows a flat waveform, end tidal carbon dioxide reads 0 mmHg, O2 saturation of 70%, BP 80/40, and HR 50 BPM (on split screen)

*(Stridor sounds heard in the background)*

*Anesthesia provider: The patient is becoming stridorous and I can see tracheal tugging*

**Screen 16:**     Close up shown of tracheal tugging

**Screen 17:**     The clinical scenario and split screen are shown

**Split screen will show reenactment of the clinical scenario**     *Anesthesia provider: Nurse call an anesthesia stat. This patient is having a laryngospasm*

*I am going to close the APL valve to 10 cmH20 and provide positive pressure*

**while also displaying the monitoring devices**

*ventilation*

The capnograph continues to show a flat waveform, end tidal carbon dioxide reads 0 mmHg, O<sub>2</sub> saturation of 70%, BP 80/40, and HR 50 BPM (on split screen)

Anesthesia provider: *The positive pressure is not breaking the laryngospasm. I will also do a jaw thrust and perform the Larson maneuver by placing pressure behind the ears*

**Screen 18:** Close up shown of jaw thrust with Larson maneuver.

**Screen 19:** The clinical scenario and split screen are shown

**Split screen will show reenactment of the clinical scenario**

The capnograph continues to show a flat waveform, end tidal carbon dioxide reads 0 mmHg, O<sub>2</sub> saturation of 70%, BP 80/40, and HR 50 BPM (on split screen)

**while also displaying the monitoring devices**

Anesthesia provider: *The patient is in laryngospasm and my efforts to break it with positive pressure and jaw thrust are not working. Can you administer 1mg/kg of propofol IV?*

Helper: *Yes, I will now administer 1mg/kg of propofol IV. This patient weights 100kg so I will be giving this patient 100mg or 10cc of propofol.*

Anesthesia helper pushes propofol and places the mask back over the patient. The capnograph continues to show a flat waveform, end tidal carbon dioxide reads 0 mmHg, O<sub>2</sub> saturation of 70%, BP 80/40, and HR 50 BPM (on split screen)

Anesthesia provider: *The patient is still in laryngospasm. I am going to give 0.5mg/kg of succinylcholine IV. This patient weighs 100kg so I am going to give 50mg of succinylcholine or 2.5cc IV.*

Anesthesia provider pushes IV succinylcholine and places the mask back over the patient. The patient starts breathing, the capnograph waveform returns to normal with an end tidal carbon dioxide reading of 50mm hg, the O<sub>2</sub> saturation increases to 95%, the BP increases to 100/70, and the HR increases to 80 BPM

Anesthesia provider: *Ok, it looks like the laryngospasm has resolved.*  
Helper: *Lets suction the patient to remove the offending stimulus so this doesn't happen again*

The patient is suctioned.

**Screen 20:** Voice over: *Lets review how the non-technical skills of recognition, decision making, and prioritization can be used to manage the scenarios or bronchospasm and laryngospasm (read through recap)*

**Recap:****Bronchospasm:**

## Recognition:

- High peak pressures
- Upward sloped capnography waveform
- Patient risk (asthmatic, smoker, light anesthesia, and airway manipulation)

## Decision Making:

- Knowing differential diagnoses
- Increased peak pressures
- Sloped capnography
- Desaturation
- Hypotension
- Expiratory wheeze

## Prioritization:

- Increase FiO<sub>2</sub> to 100%, manually ventilate patient, and call for help
- Auscultate chest to check ETT placement and patency
- Administer inhalational bronchodilator (increase volatile agent if not hypotensive and give 4-8 puffs of albuterol)
- Administer IV bronchodilator (0.1mcg/kg bolus of Epinephrine)
- Decrease tidal volumes, increase respiratory rate, and change I:E ratio to 1:3

**Laryngospasm:**

## Recognition:

- End-tidal CO<sub>2</sub> 0 mmHg
- Flattened capnography waveform
- Patient risk (airway surgery, secretions/blood in the airway, and excitement phase of anesthesia)

## Decision Making:

- Inability to mask ventilate
- Stridor
- Tracheal tugging
- Decreased SpO<sub>2</sub> saturations
- Tachycardia/Bradycardia

## Prioritization:

- Call for help
- Institute at least 5-10cm H<sub>2</sub>O with and FiO<sub>2</sub> of 100% using an anesthesia breathing circuit or bag valve mask
- Use maximum efforts to open the airway (jaw thrust, Larson maneuver, head tilt, oral or nasal airway)
- Administer IV/IM medications (ie propofol, succinylcholine, or rocuronium)

**Table 1. Demographics of Study Participants**

<b>Age Groupings 30 &amp; below and 31 &amp; above</b>				
	Frequency	Percent	Valid Percent	Cumulative Percent
30 and below	15	55.6	55.6	55.6
31 and above	12	44.4	44.4	100.0
Total	27	100.0	100.0	
<b>Critical Care Groupings into 4 years &amp; below and 5 years &amp; above</b>				
	Frequency	Percent	Valid Percent	Cumulative Percent
1-4 years	15	55.6	55.6	55.6
5+ years	12	44.4	44.4	100.0
Total	27	100.0	100.0	
<b>NAT Groupings 2<sup>nd</sup> Year and 3<sup>rd</sup> Year</b>				
	Frequency	Percent	Valid Percent	Cumulative Percent
NAT 2	18	66.7	66.7	66.7
NAT 3	9	33.3	33.3	100.0
Total	27	100.0	100.0	

**Table 2. KR-20 of Knowledge Assessment Tool**

<b>Kuder-Richardson 20 PRE-TEST</b>				
<b>Case Processing Summary</b>			<b>Reliability Statistics</b>	
	N	%	KR-20	N of Items
Valid	27	100.0	0.533	17
Excluded*	0	0.0		
Total	27	100.0		
*Listwise deletion based on all variables in the procedure.				
<b>Kuder-Richardson 20 POST-TEST</b>				
<b>Case Processing Summary</b>			<b>Reliability Statistics</b>	
	N	%	KR-20	N of Items
Valid	27	100.0	0.686	17
Excluded*	0	0.0		
Total	27	100.0		
*Listwise deletion based on all variables in the procedure.				

**Table 3. Wilcoxon Signed Rank Test**

<b>Descriptive Statistics</b>					
	N	Mean	Std. Deviation	Minimum	Maximum
Mean Scores Pre-Test	27	10.7407	2.56594	5.00	14.00
Mean Scores Post-Test	27	15.8889	1.69469	11.0	17.00
<b>Ranks</b>					
		N	Mean Rank	Sum of Ranks	
Mean Scores Post Test – Mean Scores Pre Test	Negative Ranks	0 <sup>a</sup>	0.00	0.00	
	Positive Ranks	26 <sup>b</sup>	13.50	351.00	
	Ties	1 <sup>c</sup>			
	Total	27			
a. Mean Scores Post Test < Mean Scores Pre Test b. Mean Scores Post Test > Mean Scores Pre Test c. Mean Scores Post Test = Mean Scores Pre Test					
<b>Test Statistics<sup>b</sup></b>					
		Mean Scores Post Test – Mean Scores Pre Test			
Z	-4.473 <sup>a</sup>				
Asymptotic Sig. (2-tailed)	0.000				
a. Based on negative ranks b. Wilcoxon Signed Ranks Test					

**Table 4 (a, b, c) Descriptive Data of Posttest Scores and Mann-Whitney U Statistics****Table 4a. Descriptive Data of Posttest Scores: Age**

<b>Ranks</b>				
	Age Groupings 30 & below and 31 and above	N	Mean Ranks	Sum of Ranks
Mean Scores Post Test	30 and below	15	13.33	200.00
	31 and above	12	14.83	178.00
	Total	27		
<b>Hypothesis Test Summary</b>				
Null Hypothesis	Test	Sig.	Decision	
The distribution of Mean Scores Post Test is the same across categories of Age Groupings 30 and below and 31 and above	Independent-Samples Mann-Whitney U test	0.595	Retain the null hypothesis	
Asymptotic significances are displayed. The significances level is 0.05				

**Table 4b. Descriptive Data of Posttest Scores: Critical Care Experience**

<b>Ranks</b>				
	Critical Care Groupings into 4 years & above and 5 years & below	N	Mean Ranks	Sum of Ranks
Mean Scores Post Test	1-4 years	15	13.63	204.50
	5+ years	12	14.46	173.50
	Total	27		
<b>Hypothesis Test Summary</b>				
Null Hypothesis	Test	Sig.	Decision	
The distribution of Mean Scores Post Test is the same across categories of Critical Care Groupings into 4 years & below and 5 years & above	Independent-Samples Mann-Whitney U test	0.770	Retain the null hypothesis	
Asymptotic significances are displayed. The significances level is 0.05				



**Table 4c. Descriptive Data of Posttest Scores: Anesthesia Training**

<b>Ranks</b>				
	NAT Groupings 2 <sup>nd</sup> Year and 3 <sup>rd</sup> Year	N	Mean Ranks	Sum of Ranks
Mean Scores Post Test	NAT 2	18	11.33	204.00
	NAT 3	9	19.33	174.00
	Total	27		
<b>Hypothesis Test Summary</b>				
Null Hypothesis		Test	Sig.	Decision
The distribution of Mean Scores Post Test is the same across categories NATs		Independent- Samples Mann- Whitney U test	0.007	Reject the null hypothesis
Asymptotic significances are displayed. The significances level is 0.05				

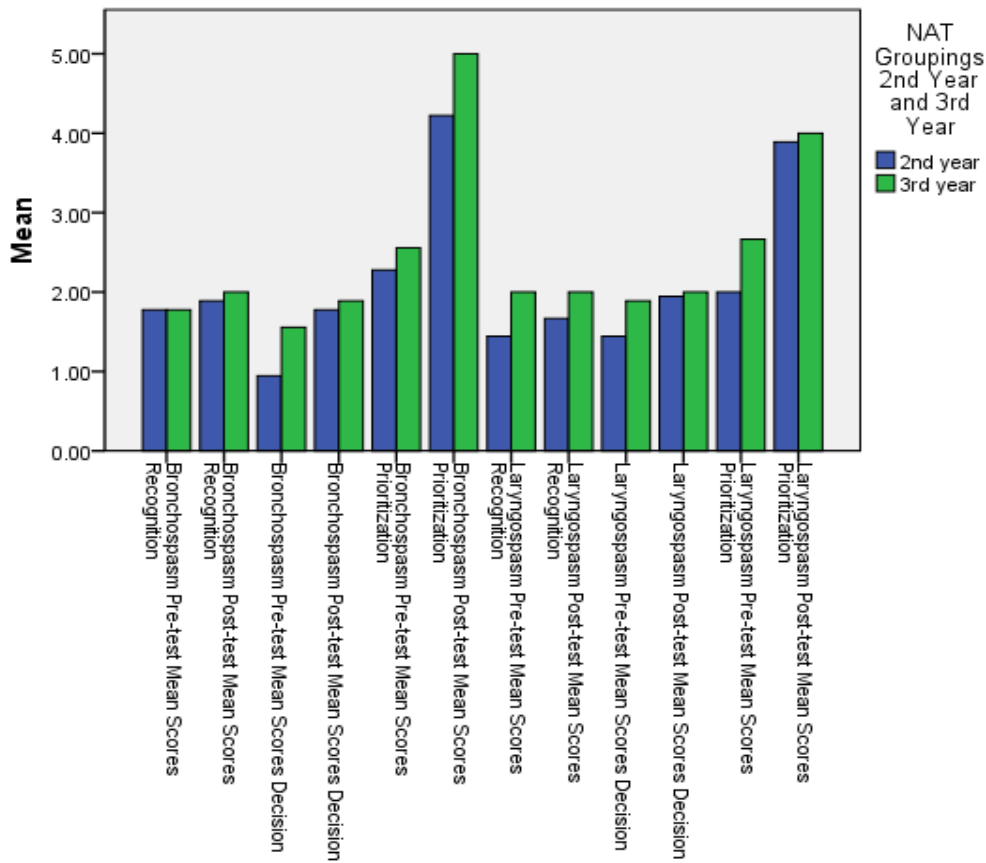
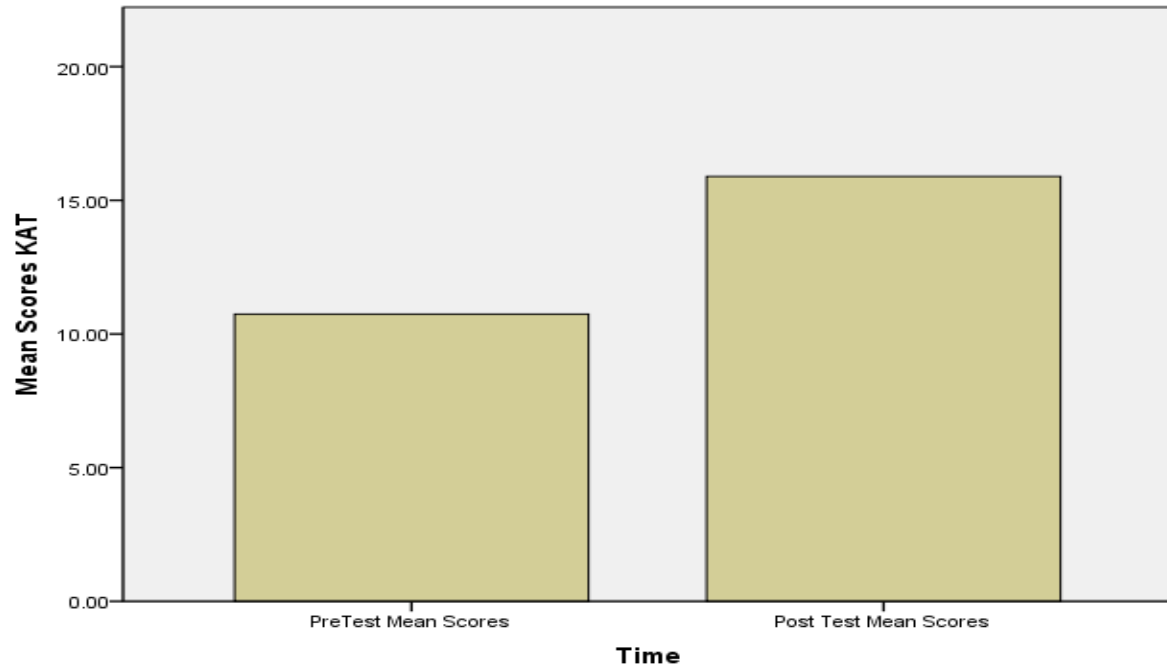
**Table 5: Paired Sample Statistics**

<b>Table 5. Descripted Statistics of KAT from Paired Samples</b>					
Pre-Test and Post-Test Mean Scores		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Bronchospasm Pre-test Mean Scores Recognition	1.7778	27	.42366	.08153
	Bronchospasm Post-test Mean Scores Recognition	1.9259	27	.26688	.05136
Pair 2	Bronchospasm Pre-test Mean Scores Decision	1.1481	27	.66238	.12747
	Bronchospasm Post-test Mean Scores Decision	1.8148	27	.39585	.07618
Pair 3	Bronchospasm Pre-test Mean Scores Prioritization	2.3704	27	1.75736	.33820
	Bronchospasm Post-test Mean Scores Prioritization	4.4815	27	1.34079	.25804
Pair 4	Laryngospasm Pre-test Mean Scores Recognition	1.6296	27	.56488	.10871
	Laryngospasm Post-test Mean Scores Recognition	1.7778	27	.42366	.08153
Pair 5	Laryngospasm Pre-test Mean Scores Decision	1.5926	27	.57239	.11016
	Laryngospasm Post-test Mean Scores Decision	1.9630	27	.19245	.03704
Pair 6	Laryngospasm Pre-test Mean Scores Prioritization	2.2222	27	.97402	.18745
	Laryngospasm Post-test Mean Scores Prioritization	3.9259	27	.38490	.07407

Table 6

		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	Bronchospasm Pre-test Mean Scores Recognition - Bronchospasm Post-test Mean Scores Recognition	-.14815	.36201	.06967	-.29136	-.00494	-2.126	26	.043
Pair 2	Bronchospasm Pre-test Mean Scores Decision - Bronchospasm Post-test Mean Scores Decision	-.66667	.67937	.13074	-.93541	-.39792	-5.099	26	.000
Pair 3	Bronchospasm Pre-test Mean Scores Prioritization - Bronchospasm Post-test Mean Scores Prioritization	-2.11111	2.04438	.39344	-2.91984	-1.30238	-5.366	26	.000
Pair 4	Laryngospasm Pre-test Mean Scores Recognition - Laryngospasm Post-test Mean Scores Recognition	-.14815	.60152	.11576	-.38610	.08980	-1.280	26	.212
Pair 5	Laryngospasm Pre-test Mean Scores Decision - Laryngospasm Post-test Mean Scores Decision	-.37037	.56488	.10871	-.59383	-.14691	-3.407	26	.002
Pair 6	Laryngospasm Pre-test Mean Scores Prioritization - Laryngospasm Post-test Mean Scores Prioritization	-1.70370	1.03086	.19839	-2.11150	-1.29591	-8.588	26	.000

**Figure 1. Bar Graphs Representing the KAT Mean Scores at Pre and Post-Instructional Video**



**Appendix H: Evidence Based Table on Non-Technical Skills and Video Simulation**

Evidence-based Table on Use of Non-Technical Skills and Video Simulation											
Study Author (Year)	Purpose	Design	Sampling & Sample	Human Subjects Issues	Questions Concerning Intervention	Outcomes Measurement Tools	Adverse Effects of Intervention	Limitation	Statistics Used	Findings	Conclusion
Finan, Bismilla, Whyte, LeBlanc, and McNamara (2012)	To compare the effects of low-fidelity simulator (LFS) to high-fidelity simulator (HFS) on performance levels and objective and subjective stress in neonatal trainees	Prospective randomized study	Convenience sample of 16 neonatal fellows at the University of Toronto. Trainees were divided into pairs and randomized to the LFS group or the HFS group	All trainees had completed the Neonatal Resuscitation Program and had advanced resuscitation training. 13 females and 3 males	Are objective and subjective stress in neonatal trainees different between LFS and HFS? How does objective and subjective stress levels affect resuscitation performance scores?	10-point likert scale on perceived stress. Salivary cortisol levels. Validated neonatal resuscitation performance (NPR) tool. Anesthesia non-technical skills scoring tool	N/A	Small sample size and high number of female participants. Convenience sample. Cannot locate the exact source of stress	Parametric and non-parametric analysis for continuous data. Chi-squared or Fisher's exact test for categorical data. Two-way repeated measures analysis of variance to compare stress measurements. Univariate analysis to identify any predictors of NPR, ANTS scores, or cortisol level about the median value	No significant difference in performance comparing performance levels between HFS and LFS with NPR scores (p=0.17). Also there was no significant difference of ANTS scores between groups (p=0.52). No difference in magnitude of subjective stress or salivary cortisol levels between LFS and HFS was discovered. Cognitive appraisal was found to negatively correlate with the ANTS score but cortisol and subjective stress was not associated	HFS may not be superior to LFS in recreating stress of real emergency situations. This may be important for facilities with limited financial resources that want to provide simulation training. The trainee's perception of stress (cognitive appraisal) determines the impact on performance and suggests an important role for stress training for improving non-technical skills
Flin and Patey (2011)	Examines non-technical skills (NTS) approach to enhance anesthesia safety	N/A	N/A	N/A	Can anesthesia utilize aviation simulation to improve non-technical skills?	The Anaesthetists' Non-Technical Skills (ANTS) taxonomy and behavior-rating tool	Anesthesia emphasizes on crisis management where aviation focuses on routine	Difficulty encountered in finding time to use ANTS to discuss and assess	N/A	ANTS comparable to similar tools available for surgeons (NOTSS), scrub nurses (SPLINTS), and aviation (CRM) Skills	Advances in anesthesia safety with NTS. Development of ANTS have proved to be a valuable

							behavior	NTS in daily practice		included situation awareness, decision making, leadership, teamwork as well as managing work stress and fatigue Behavior-rating scale has a set of 4-point rating for observed behaviors with regards to elements and categories observed	mechanism for highlighting the importance for NTS. ANTS rating scale is a useful tool for training and competence assurance.
Gordon, Darbyshire, and Baker (2012)	Improving patient safety with further educational interventions by using NTS	Systematic review, meta-analysis	N=437 research articles to a sample of 22	N/A	N/A	N/A	N/A	Aimed at capturing NTS training to enhance safety, but vague with how they are applied Lack of clarity, resulting in subjectivity with the researchers and omitting articles from the review All studies included reported positive findings, thus possible bias	N/A	Addressing human factors and poor performance of non-technical skills can lead to errors Teaching methods include: simulation and role-playing, observation, other methods, and educators Content includes: communication, error, systems, teamwork and leadership, and situational awareness	NTS education improves patient safety Importance of debriefing, feedback, and impact of fidelity of simulation, and the use of simulation to reduce error
Heskin et al. (2014)	To investigate if an intensive	Prospective cohort study with a	N=109 58 trainees starting core	Boot camp attendance was mandatory by all	Will an intensive 5-day surgical boot	Pretest and posttest multiple choice test	N/A	Was not a randomized controlled	Paired <i>t</i> tests used to compare pre	The mean posttest score showed a significant improvement	Surgical boot camp is a highly effective way to

	<p>surgical boot camp was effective in transferring knowledge, improving technical skills, and increasing confidence levels in technical and nontechnical skills at the beginning of a surgical training program</p>	<p>historical comparison group</p>	<p>surgical training in Ireland-boot camp group 51 previous year's trainees that did not complete boot camp</p>	<p>trainees but their participation in the study was optional. However, all 58 trainees participated 39 men and 19 women (boot camp group) 31 men and 20 women (non-boot camp group)</p>	<p>camp during the first week of their training provide trainees with adequate technical and nontechnical skills to "jump start" their careers? Was their end of the year assessment scores different from the scores of the previous years trainees who did not complete the boot camp?</p>	<p>testing knowledge of technical and nontechnical skills 28-item questionnaire assess self-confidence on a Likert scale Operative skills assessment as part of their Competence Assessment and Performance Appraisals</p>		<p>ed study Confidence does not imply competence in skills</p>	<p>and posttest Two-sample t tests used to compare posttest of boot camp trainees with previous year trainees Signed-rank and Wilcoxon rank-sum tests to determine if results were influenced by outliers, skewness, or non-normality Chi-square tests to compare number of trainees passing the practical examinations</p>	<p>(p=&lt;0.01) Confidence levels of technical and nontechnical skills significantly increased (p=&lt;0.01) Boot camp group achieved significantly higher scores in wound closing than the non-boot camp group, but showed similar results in excision of a lipoma, abdominal wound closure, and laparoscopic skills. A survey a year later showed that all trainees that responded to the survey (20%) felt they benefited from the course when they returned to the hospital Confidence levels were similar to the group that had not completed the course but had a full year of training</p>	<p>rapidly acquire knowledge, technical skills, and confidence by first year surgical trainees. The study also showed that the boot camp was as effective as a distributed practice method of surgical training</p>
<p>Lee et al. (2016)</p>	<p>Use of new technology such as e-learning, computer-assisted learning, and web-based applications</p>	<p>Randomized Controlled Trial</p>	<p>N=41 second-year nursing students</p>	<p>Pretest and posttest design Instructional Materials Motivation Survey (IMMS) by Keller Approval from College of Nursing IRB</p>	<p>Does using mobile-based video clip increase students perceived knowledge with the skill of urinary catheter insertion</p>	<p>It increased student's learning motivation, confidence in practice, and class satisfaction</p>	<p>Does not improve student's performance or knowledge of urinary catheterization.</p>	<p>Lack of blinding because it was implemented in an educational setting Student interaction with controls</p>	<p>SPSS version 21.0 Pretest and posttest X<sup>2</sup> tests and independent t tests performed. Independent t-test and</p>	<p>Number of viewings from a mobile-based device was significant. Learning motivation, confidence in practice, and class satisfaction were statistically significant among the students'</p>	<p>Mobile device videos are a valuable educational tool and promote nursing students with motivation, confidence, and satisfaction in learning a</p>

	improve learner satisfaction				n?			experimental group could contaminate study Four evaluators may have affected results Only one nursing skill evaluated	Pearson correlation coefficients used to test differences in learning motivation, confidence in practice, and class satisfaction.	characteristics. Students perceived usefulness of video clips as a learning material, knowledge acquisition and skill improvement showed positive correlation with learning motivation.	new clinical skill.
Lyk-Jensen, Jepsen, Spanager, Dieckmann, and Østergaard (2013)	Developing a behavioral marker system for NTS and adapting the ANTS	Qualitative, semi-structured approach	N=16	Four to six participants in each group (nurse anesthetist, anesthesiologist, scrub nurses, surgeons)	Can nurse anesthetists fit into ANTS or would adjustments need to be made?	Nurse Anaesthetists' Non-Technical Skills (N-ANTS)	Workshop participants found the new tool comprehensive, representative and relevant for assessing and providing feedback on nurse anaesthetists' NTS	Small number of participants Interview conducted in a single university hospital in Denmark	N/A	Wording of ANTS did not fit some of the elements and categories, so revisions needed to be made N-ANTS system consists of 4 categories: situation awareness, decision making, task management, and team working. All include separate subcategories /elements (15)	N-ANTS (for nurse anesthetists) was adapted from ANTS (for anesthesiologists), which includes modifications of different tasks, roles and responsibilities for nurse anesthetists
McLain, Biddle, and Cotter (2012)	To compare traditional instruction with the use of audiovisual patient safety vignettes and how they impact nurse anesthetists' recall and clinical performance	Randomized controlled crossover trial	N=24 student registered nurse anesthetists (SRNA) at Virginia Commonwealth University and Samford University were randomly divided into 2 groups using SPSS	1-way analysis of variance procedures using SPSS was done to evaluate differences between the two groups	Will SRNAs exposed to patient safety vignettes in addition to standard lecture display superior recall and clinical performance during a simulated crisis compared to those	Clinical performance was measured using 5 data collection points: 1. Time taken for SRNA to complete step 12 and 14 of FDA Anesthesia Apparatus Checkout Procedure 2. Time taken for SRNA to complete	N/A	Simulation may not accurately represent reality Small sample size There was no standardized tool to assess knowledge application related to the anesthesia	2-tailed, paired-samples <i>t</i> test was used to test the difference between means of 2 different variables	Pretest/posttest knowledge showed significant score improvement for group 2 (p=.001) (group 2= PSV-valve and written case scenario-suction) but insignificant score improvement for group 1 (p=.83) (group 1= PSV-suction and written case scenario-valve)	Crisis-oriented PSVs have the potential to affect SRNA's recall and clinical performance and had an impact on some areas of clinical performance during simulation



	ance				exposed to written case studies and standard lecture?	step 12 or until malfunctioning valve discovered  3. Time taken for SRNA to complete step 14 or until nonfunctioning suction discovered  4. Proper identification of stuck unidirectional valve  5. Proper identification of nonfunctioning suction		machine checkout		Mixed result for improved clinical performance for step 12 (valve) and step 14 (suction). Group 1(PSV-suction) showed faster clinical performance times for total machine checkout (p=.009), individual steps for identification of malfunctioning suction (p=.04), and clinical performance on correction of malfunctioning suction (p<.001) Marginally significant results for identification of stuck expiratory valve (p=.06) in both PSV and written scenarios were found	
Saiboon et al. (2014)	To evaluate the effectiveness of self-instruction on video (SIV) ability to teach emergency skills compared to face-to-face (FTF) teaching	Single-blinded randomized control trial	N= 45 first year undergraduate medical students from Cyberjaya University College of Medical Sciences were randomly divided into two groups: the FTF group (N=21) and the SIV group	The majority of these students had no prior experience with the emergency skills being tested. However, for those that did have prior experience, splinting was the most common at 13.3%	Is there any difference in learning outcomes using SIV or FTF teaching emergency skills amongst first year medical students?	An Objective Structured Clinical Examination (OSCE) tool was used. The OSCE was developed by a panel of two emergency physicians, an orthopaedic surgeon, a senior paramedic and a medical educator. The answer	N/A	Small sample size of 45 The study only focused on first year medical students and not other disciplines The study did not focus on the full aspect of assessing or	OSCE checklists were collected and analyzed using SPSS A five-point likert scale was used to assess the confidence level of students before and after learning a skill	There was no significant difference between the total mean of most skill sets learned (oropharyngeal airway insertion with bag-valve-mask ventilation, defibrillation, cervical immobilization, and limb splinting) between SIV ( 6.85 +/- 1.21) and FTF groups (6.20 +/- 1.04) (p=0.54)	First year medical students can learn emergency procedures with SIV as well as FTF teaching.

			(N=24).			checklists were then vetted by another group of medical educators and emergency physicians. The final OSCE was then tested by lecturers to assure validity.		measuring competency			
Sharpnack, Goliat, Baker, Rogers, and Shockey (2013)	Describe the effectiveness of using video simulation to formulate critical thinking skills, leadership, and quality and safety competencies in nursing students.	Quasi-experimental	N=54 students	Pretest and posttest	What is the effect of video simulation and critical thinking and quality competency scores for nursing students?	Video scenarios of common clinical issues and ethical dilemmas that required these skills.	Students had difficulty identifying relevant signs of common disease processes, handoff, and effective delegation, prioritization, and communication within the interdisciplinary team.	Small sample size, potential differences within the group can influence outcomes, and one college setting. Clinical practice would further support the use of video simulation	Creighton Simulation Evaluation Instrument (C-SEI) used to assess critical thinking skills and simulation performances. Paired sample t-test to compare pre and posttest	With repetition of video simulation, students found these exercises would help them in clinical practice and their decision-making. Students were able to formulate new knowledge from the video simulation throughout their leadership course. Posttest results showed evidence of deeper learning and understanding to these select situations	Repeated use of video simulation was to help with applying classroom knowledge to clinical practice. Interactive learning strategies promote connection of interrelated concepts.
Subramanyam, Yeramani, Hossain, Anneken, and Varughese (2016)	Developing a risk assessment tool for the occurrence of perioperative respiratory adverse events (PRAEs)	Retrospective cohort analysis, quality improvement (QI) database	N=19,059 Patients were assigned to a derivation cohort (n=8,904) if they had ambulatory anesthesia	Predictor variables were age, sex, ASA physical status, morbidly obesity, preexisting pulmonary disorder, preexisting neurologic disorder, and	Will developing a risk prediction tool improve awareness for the occurrence of PRAEs?	Risk prediction tool-measured as a composite score of occurrence of any 1 or a combination of the following intraoperative	N/A	Lack of available data on surgical procedures and other intraoperative variables, follow-up after recover	Participants in both cohorts compared using t-tests for continuous variables and X <sup>2</sup> test for discrete	The incidence of PRAE was 2.8%. A risk score of greater than or equal to 4/11 are high-risk, 1 to 3/11 are intermediate-risk, and 0/11 are low risk categories.	Risk prediction tool created, which includes 5 risk factors: age less than or equal to 3 (versus >3), ASA physical status II

	) from onset of anesthesia through discharge from recovery room in patients younger than 18 undergoing elective ambulatory surgery		between 2007-2009 or to a validation cohort (n=10,155) if they had surgery between 2010-2012	location of ambulatory anesthesia IRB approval obtained		events: laryngospasm or bronchospasm; or postoperative events: apnea/hypoxemia, bronchospasm, laryngospasm, or prolonged oxygen requirement.		Operating room was not performed, and data on serious perioperative morbidity and mortality were not available. There is no universally accepted definition of PRAEs	variable The model discrimination was assessed using the C-statistic model, Model calibration was assessed by Hosmer-Lemeshow statistical analysis was conducted using SAS version 9.4	Those scored 4 or greater had a negative predictive value of 98.2 +/- 0.002, positive predictive value of 5.8 +/- 0.003, sensitivity of 77.6 +/- 0.020 and specificity of 49.2 +/- 0.005 in the derivation cohort. Discriminant performance of the tool in the validation cohort had 99.1 +/- 0.001 negative predictive value, 2.8 +/- 0.002 positive predictive value, 76.2 +/- 0.030 sensitivity, and 49.7 +/- 0.005 specificity.	and III (versus ASA status I), morbid obesity, preexisting pulmonary disorder, and surgery (versus radiology) to predict the risk of PRAE
Tassoudis et al. (2016)	Obesity and the increased risk for perioperative bronchospasm in laparoscopic surgery	Prospective observational study	N= 100 obese and 50 normal weight	Comparing obese versus normal weight patients	Do obese patients have an increased risk of bronchospasm compared to non-obese patients?	No tool was used, but standardized diagnosis and treatment during the study was implemented with the diagnosis of bronchospasm: intense wheezing by auscultation, reduced tidal volumes, increased circuit pressure, and prolonged expiration	N/A	Small sample size, relatively young and healthy obese patients. Absence of preoperative pulmonary function data in obese patients	G*Power Version 3.1.9 sample size calculation SPSS v.17 statistical software package for data analysis Categorical variables compared using Chi square or Fisher's exact test	Six patients had bronchospasm all in obese group (p=0.027) Obese patients with bronchospasm had higher peak airway pressure compared to obese patients without bronchospasm	No clear understanding why bronchospasm was higher in obese patients, but can be related to increased bronchial excitability, common airway irritants, and more prone to spasms. Morbidly obese patients are affected by serious health problems: increased metabolic needs,

						with visible upslope on the capnogram due to increased airway resistance.					hypervolemia, increased cardiac output, and enlarged pulmonary vascular system. These factors can lead to hypoventilation and arterial blood desaturation. Perioperative bronchospasm is an issue in obese patients undergoing laparoscopic surgery
Wunder (2016)	To determine if an education intervention on nontechnical skills could improve the performance of nontechnical skills during anesthesia crisis simulation of first-year student registered nurse anesthetists (SRNA)	Quasi-experimental pretest/posttest	Convenience sample of 33 first-year SRNAs from the university	N/A	Will the mean posttest score for nontechnical skills be greater than the mean pretest scores for nontechnical skills after SRNAs receive a 3-hour education instruction of nontechnical skills through a digital slide?	Anaesthetists' Non-Technical Skills system (ANTS)	N/A	Lack of inter-rater reliability testing and student familiarity	1-tailed, paired-sample <i>t</i> test	Mean scores of the posttest (13.3, SD=1.73) were higher than the mean scores on the pretest (12.7, SD=2.12), which was statistically significant (p=0.028) The mean gain on scores for nontechnical skills was significantly higher than technical skills (p=0.04)	Nontechnical skills are not acquired through experience, but improved through instruction

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