NO DESAT: The Use of Nasal Oxygen During Preoxygenation and Tracheal Intubation of Obese Patients Undergoing General Anesthesia

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DNP Scholarly Project Proposal Initial Approval

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From: Dr. Susan Lown, Course Coordinator NURS 715

Re: DNP Project Proposal Review Council Endorsement

Date: 11-12-2020

DNP Scholarly Project Title: NO DESAT: The Use of Nasal Oxygen During Preoxygenation and Tracheal Intubation of Obese Patients Undergoing General Anesthesia

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Date of initial approval by DNP Scholarly Project Review Council: 11-12-2020

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DNP Scholarly Project Final Approvals

The DNP student Sable **and the Scholarly Project** NO DESAT: The Use of Nasal Oxygen During Preoxygenation and Tracheal Intubation of Obese Patients Undergoing General Anesthesia **meet all the requirements for the degree of Doctor of Nursing Practice at University of Saint Francis-Fort Wayne, IN.**

Date of Final Approval: 6/18/21

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DNP Abstract Title: NO DESAT: The Use of Nasal Oxygen During Preoxygenation and Tracheal Intubation of Obese Patients Undergoing General Anesthesia

Background and Problem Statement: As the prevalence of obesity continues to incline in the United States, so too will the proportion of surgical patients who are obese. Several physiologic factors put obese patients at risk during anesthetic induction. After anesthetic induction, obese patients experience a 50% decrease in their functional residual capacity (FRC) as compared to only a 20% decrease in FRC seen in non-obese patients, which ultimately decreases the time to desaturation during apnea. A nasal cannula is the technique of choice when providing apneic oxygenation. While the patient is awake, oxygen should be delivered via nasal cannula at five liters per minute during preoxygenation and increased to up to 15 liters per minute when the patient becomes apneic. After successful intubation, the flow of oxygen should be turned off.

Purpose/Objectives: The purpose of this project was to increase the awareness, knowledge, and employment of the NO DESAT technique in clinical practice. The objectives of the project were to educate CRNAs and SRNAs about the NO DESAT technique.

Procedures: An invitation to participate in a pre-test, educational PowerPoint, post-test, and post-educational survey was sent through email to all 553 members of the Indiana Association of Nurse Anesthetists. At the conclusion of the project implementation, 24 respondents were included in the pre and post-intervention data analysis.

Outcomes: After comparing mean scores on the pre and post-test, there was a statistically significant difference in pre and post-test results following the educational PowerPoint. The post-test mean scores increased over 35% as compared to the pre-test mean scores.

Conclusions: Enhancing safety during anesthetic induction in the obese patient population is vital. The NO DESAT technique has shown to be effective in increasing the time to desaturation and increasing the lowest SpO_2 during anesthetic induction. An educational presentation or PowerPoint presentation such as the one used in this project is an effective method to enhance provider knowledge and ultimate use of the NO DESAT technique in the clinical setting.

Chapter 1: Introduction

The induction of anesthesia is a crucial point in the perioperative period and is a time that is particularly stressful for anesthesia providers as they attempt to manage the patient's airway and hemodynamics. While it is challenging for anesthesia providers to predict if a patient will be a difficult intubation, patients who are obese present a significant challenge to anesthesia providers and have several factors that put them at risk for difficult intubation. Additionally, obese patients are more apt to rapidly desaturate while apneic during anesthetic induction as compared to non-obese patients, which presents another challenge for anesthesia providers (Nimmagadda et al., 2016). While techniques such as preoxygenation and a "stacked" or "ramped" position are often utilized by anesthesia providers when they are to induce an obese patient, another technique called NO DESAT (Nasal Oxygen During Efforts Securing a Tube) is an apneic oxygenation technique that is more often than not omitted by anesthesia providers. Apneic oxygenation provides a means to passively deliver oxygen to the lungs of an apneic patient and increase the time to desaturation as a result. The purpose of this DNP Scholarly Project was to educate both certified registered nurse anesthetists (CRNAs) and student registered nurse anesthetists (SRNAs) who were members of the Indiana Association of Nurse Anesthetists (INANA) about the benefits of NO DESAT and increase the use of the technique in the clinical setting.

Problem/Background of the Problem

As the prevalence of obesity continues to incline in the United States, so too will the proportion of surgical patients who are obese. Between 2017-2018, the prevalence of obesity (defined as a BMI of 30 or greater) among adults in the United States was 42.4%, affecting over 90 million people (Centers for Disease Control and Prevention [CDC], 2018). There are several physiologic and anatomic factors that put obese patients at risk during the induction of anesthesia. First, following the induction of anesthesia, obese patients experience a 50% decrease in their functional residual capacity (FRC) as compared to only a 20% decrease in FRC seen in non-obese patients (Murphy & Wong, 2013). The decreased FRC seen in obese patients decreases the time to desaturation (defined as an SpO_2 <90%) during apnea, which is the absence of patient respiratory effort following the administration of anesthetic induction agents (Langeron et al., 2014). Apnea continues until mechanical ventilation of the lungs is achieved or until the patient resumes spontaneous ventilation (Jense et al., 1991). During the apneic period, the average time to reach an SpO_2 of 90% in patients with a normal body habitus is six minutes as compared to only 2.7 minutes in the morbidly obese patient, which means that obese patients are at significantly higher risk for complications associated with desaturation (Nimmagadda et al., 2016). Anatomically, obese patients have increased adipose tissue within pharyngeal structures and a limited movement of the atlantoaxial joint (Dority et al., 2011; Murphy & Wong, 2013). Combined, these differences make obesity an independent predictor of both difficult mask ventilation and tracheal intubation (Murphy & Wong, 2013). The anatomical and physiological differences combined cause the rate of difficult intubation to be 15.5% in obese patients (BMI > 30) as compared to only 2.2% in non-obese patients (Juvin et al., 2003).

On a national scale, adverse respiratory events encumber a large portion of adverse anesthesia events in the perioperative period. Between the years 1990 and 2007, adverse respiratory events accounted for 31.8% of closed anesthesia malpractice claims of the American Association of Nurse Anesthetists (AANA) (Pratt & Miller, 2016). Of the closed anesthesia malpractice claims of the American Society of Anesthesiologists (ASA), 27% of all adverse respiratory events were attributed to difficult airway management, with 67% occurring on induction (Pratt & Miller, 2016). Desaturation during the apneic period of anesthetic induction increases the anxiety of the anesthesia provider and puts the patient at risk for serious and potentially life-threatening complications in the perioperative period including atelectasis, ventilation/perfusion mismatch, hypoxemia, and even cardiac arrest (Langeron et al., 2014; Pavlov et al., 2017). After reviewing major complications of airway management, the United Kingdom Fourth National Audit Project reported a fourfold increase in the risk of serious complications associated with airway management of morbidly obese patients (Cullen & Ferguson, 2012; Murphy & Wong, 2013).

According to Weingart and Levitan (2012), a nasal cannula is the technique of choice when providing apneic oxygenation, hence the acronym NO DESAT. While the patient is awake, oxygen should be delivered via nasal cannula at five liters per minute during preoxygenation and increased to up to 15 liters per minute when the patient becomes apneic during anesthetic induction (Mushambi et al., 2014). After successful intubation, the flow of oxygen should be turned off and the nasal cannula removed. With optimal conditions, the partial pressure of oxygen in arterial blood (PaO_2) can be maintained at around 100 mmHg for up to 100 minutes even without the administration of manually assisted breaths or the patient spontaneously breathing (Weingart & Levitan, 2012).

Several studies using a nasal cannula as the method of apneic oxygenation administration have been performed and support its use in clinical practice. A study of obese males by Wong et al. (2019) found that when continuous nasal oxygen at five liters per minute was delivered, SpO_2 greater than or equal to 95% in the group receiving oxygen was significantly longer than those who did not receive oxygen (5.29 +/- 1.02 minutes versus 3.49 +/- 1.33 minutes). Additionally, the lowest SpO_2 in the group who received oxygen was greater than those who did not (94.3 +/-

4.4% versus 87.7 +/- 9.3%) (Ramachandran et al., 2010). Another study of morbidly obese patients found that high-flow nasal oxygenation prolonged the safe apnea time by 76 seconds (40%) in the morbidly obese surgical patient compared to facemask oxygenation (Wong et al., 2019).

A narrative review by Wong et al. (2017) found that out of 12 operating room studies on the effectiveness of apneic oxygenation, all 12 found that apneic oxygenation decreased the incidence of desaturation and prolonged the duration to desaturation. A systematic review and meta-analysis of 10 studies with a total of 2,322 patients by Tan et al. (2017) found that apneic oxygenation was beneficial and reduced the incidence of oxygen desaturation during the apneic period of anesthetic induction. King and Jagannathan (2018) suggested that apneic oxygenation techniques become the standard of care for obese adults undergoing endotracheal intubation. Thus, the purpose of this DNP Scholarly Project is to increase the awareness, knowledge, and employment of NO DESAT by CRNAs and SRNAs in the clinical setting.

Needs Assessment and Practice/Knowledge Gap

In the state of Indiana, 34.1% of adults are obese (America's Health Rankings, 2019). As a result, of all the surgical patients requiring endotracheal intubation in Indiana, anesthesia providers are faced with a significant proportion of patients at high risk for rapid desaturation while apneic and the potential for being a difficult intubation. As many CRNAs in Indiana work independently and are often the sole anesthesia providers available in an entire facility at a given time, preemptive safety measures are needed to be in place, particularly in patients known to be at risk for both difficult mask ventilation and intubation. Despite this, many anesthesia providers who are members of the INANA may have never been educated about the NO DESAT technique and, as a result, never employed NO DESAT in clinical practice. The employment of NO

DESAT with the same frequency as a ramped position and preoxygenation in obese surgical patients by anesthesia providers in Indiana could help prolong the safe apnea period for a considerable number of patients requiring endotracheal intubation in hospitals throughout the state.

DNP Project Overview

PICO Question

The PICOT question addressed in this project is: After education regarding the benefits of apneic oxygenation (NO DESAT), will CRNAs and SRNAs be more likely to employ apneic oxygenation techniques on adults with a body mass index (BMI) of 30 or greater undergoing endotracheal intubation?

Project Design Type

The project design appropriate for this DNP Scholarly Project is a Quality Improvement (QI) Project designed to increase members of the INANA knowledge and, ultimately, use of NO DESAT in obese patients undergoing endotracheal intubation.

Scope of Project

The DNP Scholarly Project did not include research on actual participants and focused solely on CRNA and SRNA knowledge and quality of care improvement. The participants of this DNP Project include both CRNAs and SRNAs who are members of the INANA. There was no physical setting for the implementation of this DNP Project as Kim Williams, the INANA Chapter Administrator, distributed the demographic questionnaire and pre-test electronically by email to all members of the INANA, followed by an educational PowerPoint about apneic oxygenation and the NO DESAT technique and its benefits in the obese patient population. Finally, a post-test and post-educational survey was distributed by email to assess for knowledge gain following participant viewing and listening of the voiceover educational PowerPoint. Through evaluation of a pre and post-educational test using the statistical software SPSS, the project manager sought to improve both awareness and knowledge of NO DESAT and the benefits in the obese surgical patient.

Stakeholders

Stakeholders in the DNP Project included the DNP Project manager (Sable Yrjanson, SRNA), DNP Project Advisor (Dr. Megan Winegarden), INANA President (Dr. Greg Louck), INANA Chapter Administrator (Kim Williams), and members of the INANA including both CRNAs and SRNAs.

Budget and Resources

Cost

In-kind costs were provided by the Nurse Anesthesia Program faculty and Doctoral faculty from the University of Saint Francis (USF) for assisting with the planning, implementation, and evaluation phases of the DNP Scholarly Project both in in-person and virtual meetings. Microsoft Forms allowed for the collection of deidentified participant responses and data analysis and was provided free of charge for USF graduate students. The direct costs of the DNP Project included the use of SPSS, which is an online statistics software system that was used to perform statistical analysis on the collected data. SPSS Standard Grad Pack Student (version 26) was purchased for $76 by the project manager. The distribution of the pre and post-tests and questionnaires by Kim Williams was free of charge. There was no cost or charge to INANA members to participate in the DNP Scholarly Project. In total, the direct costs for the project was $76 and was incurred by the project manager.

Description of Resources

Resources for the implementation of the DNP Scholarly Project included INANA President, Dr. Greg Louck, and INANA Chapter Administrator, Kim Williams. The pre and post-surveys were distributed by email to INANA members. Other resources included the use of Microsoft Forms to distribute and collect surveys and their responses, and SPSS, which is a statistical software that assisted in data analysis.

Process and Outcomes

General timeline

The timeline for this project (see Appendix A) occurred from January 2020 to the completion of the project, June 2021. Planning for the DNP Project and communication with stakeholders of the project occurred throughout the year of 2020. USF IRB approval was granted in October of 2020. The implementation of the project occurred from January 18, 2021 to February 1, 2021, with data collection and analysis occurring the following week (February 2-9) and through the spring semester of 2021. Dissemination of project findings occurred in June of 2021.

Project Setting and Target Population

The location for the implementation phase of the DNP Project was whatever location members of the INANA were able to complete the pre and post-test, post-educational survey, demographic questionnaire, and educational PowerPoint. There was no physical setting for the implementation of the DNP Project as it was distributed by email to members of the INANA. The DNP Project focused on participants who were practicing CRNAs and SRNAs who were current members of the INANA. Criteria for exclusion included CRNAs who were retired or no longer practicing, as well as physician anesthesiologists and the project manager.

Aims/Outcomes

Upon the completion of the DNP Project, expected outcomes meeting the aims of the project included the following:

- Aim 1: To evaluate CRNAs and SRNAs baseline knowledge, knowledge gain, and perceived knowledge following the educational in-service regarding apneic oxygenation and its benefits in the specified patient population.
    - Outcome/Indicator 1a: Following the education session, CRNA and SRNA mean scores on the post knowledge questionnaire will increase by 15% compared to the baseline knowledge questionnaire.
    - Outcome/Indicator1b: At least 80% of all CRNAs and SRNAs will self-report that their perceived knowledge of apneic oxygenation has been enhanced following the education session.
- Aim 2: To evaluate CRNAs' and SRNAs' perceived barriers to utilizing apneic oxygenation techniques in the clinical setting and CRNA and SRNA confidence in addressing the identified barriers in clinical practice.
    - Outcome/Indicator 2a*:* Following the education session, CRNAs and SRNAs will identify the most common barrier they foresee to utilizing apneic oxygenation techniques in the clinical setting.
    - Outcome/Indicator 2b: Following the education session, at least 60% of CRNAs and SRNAs will rate themselves as feeling confident in addressing the perceived barriers to the utilization of apneic oxygenation techniques in the clinical setting.

- Aim 3: To increase both CRNAs' and SRNAs' confidence and thereby use of apneic oxygenation techniques during endotracheal intubations in the clinical setting.
    - Outcome/Indicator 3a: Following the education session, at least 75% of CRNAs and SRNAs will self-report having the confidence to employ apneic oxygenation techniques in clinical practice.
    - Outcome/Indicator 3b: Following the education session, at least 75% of CRNAs and SRNAs will self-report being likely to use apneic oxygenation techniques in their future clinical practice.

Risk Analysis

There were no anticipated risks or discomforts for those who participated, and participants encountered no harm or damages as a result of participating in the DNP Project. Informed consent (see Appendix B) was required to be obtained from participants prior to allowing participants to complete any portion of the DNP Project and was obtained by an electronic form. On the informed consent form, participants were made aware that participation in the pre-test, demographic questionnaire, educational presentation, and post-test and post-educational survey was strictly voluntary. The informed consent also stated that participant privacy and confidentiality would be ensured and that survey and questionnaire responses through Microsoft Forms would remain anonymous. Additionally, the pre-test, demographic questionnaire, post-test, and post-educational survey responses were deidentified in Microsoft Forms to protect participant identity and privacy. Participant name, facility of employment, or any other identifying information was not collected from participants by the project manager to ensure anonymity. Data was stored in aggregate form. Additionally, to ensure privacy and confidentiality of INANA members, the project manager did not have access to INANA members' email. Any direct communication regarding the project to members of the INANA was made through Kim Williams, the INANA Chapter Administrator or to the contact information provided on the informed consent form (see Appendix B).

The DNP Project did not include the conduction of research on participants and was solely a quality improvement project.   Participants received no compensation for their responses nor were charged at any time for participating. Participation in the project was solely voluntary and subjects were at no risk for harm for participating in the project.

Chapter 2: Synthesis of Supporting Evidence and Project Framework

Relevant Theory and Concepts

Pathman's Pipeline Model was used for the implementation of this DNP Scholarly Project. Pathman's Pipeline Model was developed by Dr. Donald Pathman and colleagues (Pathman et al., 1996). The group studied physician adherence to national vaccine recommendations for pediatric patients and based upon their findings developed a four step model that described how likely physicians were to comply with practice guidelines if they became aware of the guidelines, agreed with the guidelines, adopted the guidelines, and ultimately adhered to the guidelines in clinical practice (Pathman et al., 1996). Initially named the awareness-to-adherence model, the group found that physician awareness of infant hepatitis B vaccination recommendations was 98.4%, 70.4% agreement, 77.7% adoption of the guidelines, and 30.1% adherence to the guidelines (Pathman et al., 1996). The group described how the model could be used to improve physician adherence to any best-practice guideline by identifying which stage physicians fail to adhere to guidelines, as well as the factors associated with achieving adherence to guidelines in the clinical setting (Pathman et al., 1996).

While the steps described by Pathman et al. (1996) were useful in evaluating physician adherence to guidelines, the model can be further utilized to assist a variety of healthcare workers in adhering to guidelines in clinical practice. A systematic review of 11 studies (reporting on a total of 29 recommendations) that utilized Pathman's four steps found that, similar to Dr. Pathman and his colleagues, leakage was present and progressive through all four steps (awareness, agreement, adoption, and adherence) (Mickan et al., 2011). Mickan et al. (2011) studied a multitude of different recommendations including anesthetic practice guidelines, drug interventions, medical management, health promotion, and screening tests and found that the median adherence to recommendations was only 34%. The results of this systematic review suggest that not only does leakage occur from the time a guideline is published to adherence, but that there are multiple factors associated with failure to adhere to clinical guidelines and high-quality research evidence (Mickan et al., 2011). Additionally, the failure to adhere exists in a variety of specialties, healthcare systems, and at all steps of the model (Mickan et al., 2011). Ultimately, more must be done to facilitate the sustained adherence to best-practice recommendations in the clinical setting.

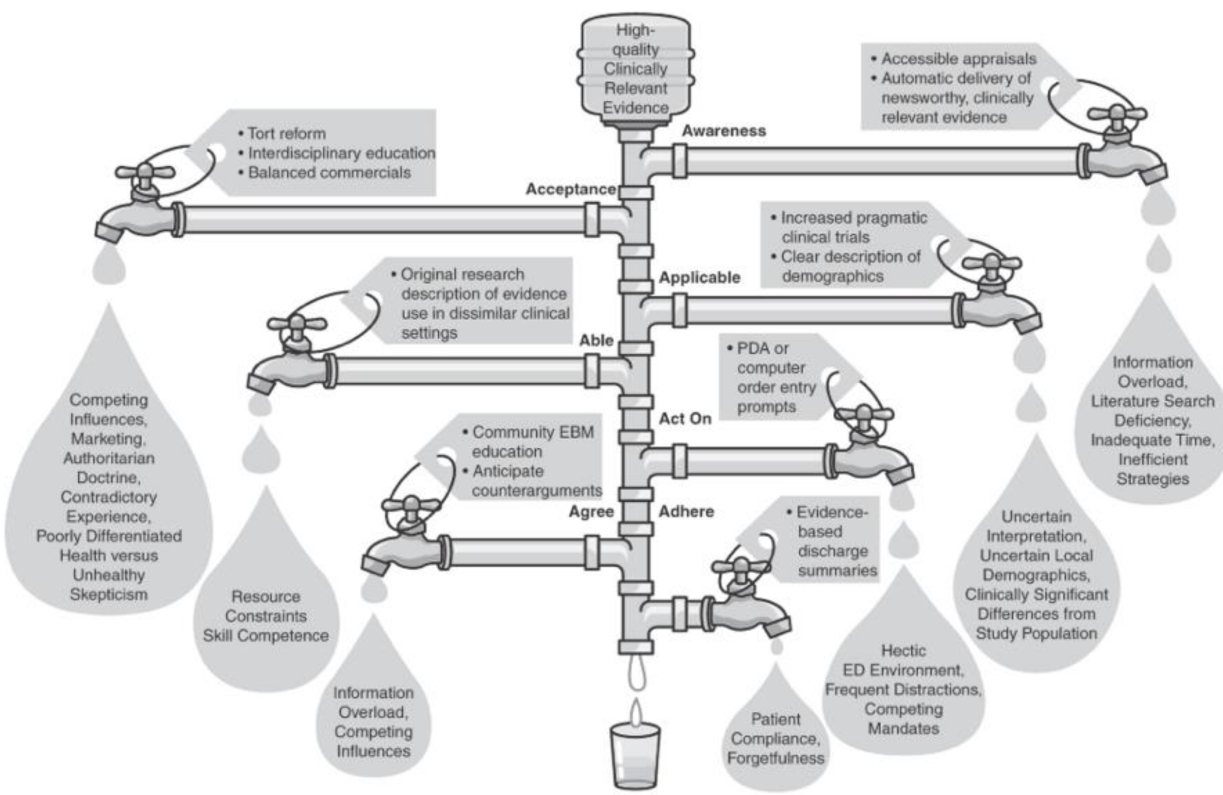
Major Concepts

A main concept of Pathman's Pipeline Model is that the model is especially useful in identifying factors underlying adherence to practice change, yet also appreciates that each situation where the model can be applied has its own complexities and need for individualization (White, 2016). Second, the model assists its user in examining which factors facilitate or hinder the movement of knowledge through the aforementioned steps (Glasziou & Haynes, 2005). The awareness-to-adherence model was later expanded upon with a visual depiction showing a water pipeline with both faucets and leaks that represent the stages of moving evidence to the bedside (Glasziou & Haynes, 2005). Additional stages were added to the model based on a systematic review of barriers to evidence translation (Cabana et al., 1999). As depicted in Figure 1, there are currently seven faucets (stages) that represent the steps for the translation of evidence into bedside practice and include awareness, acceptance, applicable, able, act on/adopt, agree, and adhere (Cabana et al., 1999; White, 2016). As always, barriers to implementation can occur at any one of the stages.

There are specific stages throughout the pipeline where leakage occurs which results in a reduced transfer of evidence during each stage (Wimpenny et al., 2007). Figure 1 gives an illustrative example of a leaky pipeline with the seven stages that directly apply to the employment of apneic oxygenation techniques by anesthesia providers for obese adults in the operating room. The drops of water are examples of lost or misused information at each stage; the tags around the faucets show the viewer how to slow, or altogether stop, the leakage of knowledge and prevent barriers to evidence translation in clinical practice (Diner et al., 2007). While the first five leaks deal with clinicians and other members of the health care team, the final two leaks are representative of the patient's environment (Diner et al., 2007). The following paragraphs will discuss how Pathman's Pipeline Model was used to identify and prevent barriers to evidence translation to the bedside as it relates to this DNP Project.

Figure 1

Pathman's Pipeline Model



Graphic adapted from "Graduate medical education and knowledge translation: Role models, information pipelines, and practice change thresholds," by B. M. Diner, C. R. Carpenter, T. O'Connell, P. Pang, M. D. Brown, R. A. Seupaul, J. J. Celentano, & D. Mayer, 2007, *Society for Academic Emergency Medicine, 14*(11). Copyright 2005 by ACP J Club.

Pathman's Pipeline Model as it Relates to DNP Project

In the stage of "awareness," the leaky faucet of information overload, inadequate time, et cetera, was turned off by providing evidence supporting both the physiologic mechanisms of apneic oxygenation and the employment of apneic oxygenation techniques in clinical practice. The barriers to "acceptance," among which include skepticism and contradictory experience, was addressed by providing participant education on how to provide apneic oxygenation techniques. In the "applicable" stage, barriers to employment of apneic oxygenation techniques included uncertain interpretation of the demographics of the study participants and applicability of using the technique in one's own practice. This was addressed by providing participants a clear description of what patient population and setting apneic oxygenation techniques should be employed.

In the "able" and "act on" stage, barriers included resource constraints, skill competence, and a hectic environment. This was addressed by explaining the ease of employing apneic oxygenation in clinical practice, as well as explaining its low cost to both the facility and the patient.

Barriers to Project Implementation

A significant barrier to the implementation of apneic oxygenation techniques in all obese patients undergoing general anesthesia with tracheal intubation was the fact that there is a high volume of research available on nearly every subject regarding anesthesia delivery. Volume overload can make it difficult for providers to be aware of every guideline or best practice policy and apply it in the clinical setting (Cabana et al., 1999). Additionally, lack of awareness and familiarity, the inertia of everyday practice, and a lack of agreement were additional barriers to clinicians adhering to clinical guidelines in practice (Cabana et al., 1999). According to Glasziou et al. (2005), the first large hurdle in implementing a practice change is the initial awareness of high-quality research on the part of anesthesia providers. However, it is important to note that even if initial awareness of evidence occurs, the awareness of the evidence has little impact on practice if the other stages of implementation are not addressed (Glasziou et al., 2005). Focus on all stages of the model was vital in order to educate anesthesia providers using high-quality research evidence (Glasziou et al., 2005). Pathman's Pipeline Model assisted in addressing some of the foreseeable, and some of the not so foreseeable, barriers to the implementation of this project.

Review of Literature

Overview of the Standard Anesthetic Induction for General Anesthesia

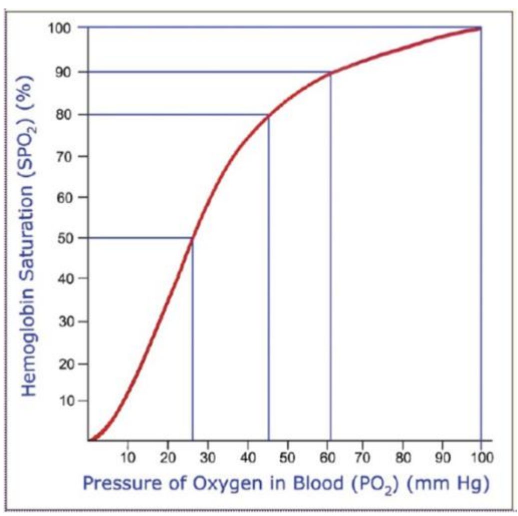
In non-critically ill surgical patients undergoing general anesthesia with tracheal intubation, the standard anesthetic induction begins with preoxygenation of the patient. This usually is administered by a face mask with 100% oxygen. The goal of preoxygenation is to bring the patient's oxygen saturation as close to 100% as possible, as well as to washout alveolar nitrogen and saturate the FRC of the lungs with 100% oxygen (Bignami et al., 2019; Nimmagadda et al., 2017; Weingart & Levitan, 2011). Patients should ideally receive preoxygenation until the end-tidal oxygen level is greater than 90% and the end-tidal nitrogen is less than 5% (Bignami et al., 2019; Weingart & Levitan, 2011). For most patients, this can be achieved with either a minimum of three minutes of tidal-volume breathing or eight vital-capacity breaths, provided that the source of FiO_2 is greater than or equal to 90% and there is a tight fitted mask that provides minimal entrainment of room air (Weingart & Levitan, 2011). Indications of adequate preoxygenation include an increase in the fraction of alveolar oxygen (F_{AO2}), a decrease in the fraction of alveolar nitrogen (F_{AN2}), and an increase in arterial oxygen tension (P_{aO2}) (Nimmagadda et al., 2017). Preoxygenation is recommended in all patients undergoing general anesthesia as it lengthens the time to safely perform laryngoscopy and grants the anesthesia provider a longer timeframe to respond to a cannot intubate, cannot ventilate scenario (Bignami et al., 2011). Because the cannot intubate, cannot ventilate scenario is difficult to predict, preoxygenation is recommended in all surgical patients undergoing general anesthesia (Nimmagadda et al., 2017). Following adequate preoxygenation, the anesthesia provider administers a sedative and then provides manual ventilations when the patient becomes apneic. Next, a muscle relaxant is administered, and manual ventilation is resumed until neuromuscular blockade has taken full effect and the endotracheal tube is placed (Weingart & Levitan, 2011).

Physiologic Basis of Preoxygenation and Apneic Oxygenation

To understand the basis of preoxygenation, it is vital to first understand the physiology behind preoxygenation and the oxyhemoglobin dissociation curve. Adequacy of preoxygenation is, in part, assessed with oxyhemoglobin desaturation during apnea (Nimmagadda et al., 2017). The sigmoid shape of the oxyhemoglobin dissociation curve reflects the association between oxygen and hemoglobin molecules, and oxygen saturation varies with the PaO_2 in a nonlinear fashion (Madan, 2017). As depicted in Figure 2 below, the oxyhemoglobin dissociation curve is initially steep before it flattens out (Madan, 2017). The significant takeaway is that when the patient's pulse oximetry (SpO_2) falls below 90%, the PaO_2 rapidly declines (as depicted) and oxygen delivery to the tissues is decreased (Madan, 2017; Nimmagadda et al., 2017; Pavlov et al., 2017). The curve is mostly flat when the PaO_2 is above 90 mmHg, and it is at this point when the saturation of hemoglobin (SpO_2) will change very little despite significant changes in PaO_2 (Madan, 2017). The upper part of the curve serves as a buffer in that the PaO_2 can drop to around 60 mmHg while the hemoglobin still remains highly saturated (~90%) with oxygen (Madan, 2017). The nonlinear relationship between oxygen saturation and PaO_2 depicted by the oxyhemoglobin dissociation curve reflects the many factors that can affect these variables, including temperature, pH, 2,3 diphosphoglycerate (DPG), and the partial pressure of carbon dioxide in arterial blood ($PaCO_2$) (Madan, 2017). Figure 2 below shows the nonlinear relationship between SpO_2 and PO_2.

Figure 2.

Oxyhemoglobin Dissociation Curve



Adapted from "Correlation between the levels of SpO_2 and PaO_2," by A. Madan, 2017, *Lung India, 34*(3), 307-308. Copyright 2017 by the Indian Chest Society.

Innate physiologic factors also affect the way in which humans exchange gas between the bloodstream and alveoli. In the 70-kilogram adult, metabolic oxygen consumption is approximately 250 milliliters per minute whereas carbon dioxide (CO_2) production is 200 milliliters per minute (Pavlov et al., 2017). As discussed earlier, preoxygenation denitrogenates the FRC. When this occurs, oxygen diffuses from the alveoli into the bloodstream at a rate of 250 milliliters per minute (Pavlov et al., 2017). At the same time, CO_2 stops being eliminated and instead diffuses into the alveolar space at a rate of 10 milliliters per minute (Pavlov et al., 2017). The CO_2 production coupled with the absence of CO_2 elimination and oxygen diffusion out of the alveoli results in a net gas flow of 240 milliliters per minute from the alveoli and into the blood, thereby causing a negative pressure gradient (Pavlov et al., 2017). The negative pressure gradient results in entrainment of ambient gases into the patient's lungs (Pavlov et al., 2017). As room air gases consist of approximately 79% nitrogen and 21% oxygen, nitrogen ultimately accumulates in the lungs and desaturation occurs as a result (Pavlov et al., 2017). With preoxygenation, the period prior to desaturation (defined as an SpO_2 less than or equal to 90%) can be increased from one to two minutes (without preoxygenation) to eight minutes (Frerk et al., 2015). Why this is particularly significant in the obese population will be discussed next.

The Safe Apnea Period Explained

As discussed earlier, anesthetic induction is associated with a period of apnea. Apnea lasts until mechanical ventilation of the lungs is achieved or until the patient resumes spontaneous ventilation (Jense et al., 1991). The safe apnea period is defined as the period of time between the onset of apnea and an SpO_2 of 90% or lower, the point at which hypoxia ensues (Jense et al., 1991; Pratt & Miller, 2016; Tanoubi et al., 2009). During this safe apnea time the body continues to require oxygen, and it is from the FRC that oxygen is supplied (Jense et al., 1991). The FRC is the most important source for oxygen storage in the body (Sirian & Wills, 2009). When oxygen within the FRC is maximized, apnea can be longer tolerated before hypoxia develops (Sirian & Wills, 2009). At end expiration, the alveolar fraction of oxygen (F_{AO2}) is approximately 16% in patients breathing room air; this increases to 95% in patients breathing pure oxygen, with the remaining 5% consisting of carbon dioxide (Tanoubi et al., 2009). If FRC is equal to 2500 milliliters in the average adult, the oxygen reserve is 2,125 milliliters when preoxygenation is administered, which is around ten times their oxygen consumption and is significantly higher compared to the patient breathing room air who only has 150 milliliters of oxygen reserve (Sirian & Wills, 2009; Tanoubi et al., 2009). Since oxygen consumption is around 250 milliliters per minute, the 2,125 milliliters of oxygen in the patient's lungs can provide 8.5 minutes of apnea; for a healthy adult with a normal FRC and oxygen consumption, complete oxygen consumption of the lungs would occur within one minute if preoxygenation is not delivered (Sirian & Wills, 2009; Tanoubi et al., 2009).

Anatomic and Physiological Differences Between Obese and Non-Obese Adults

Both the anatomic and physiologic differences seen in obese patients must be considered when providing anesthesia and airway management to this patient population. Anatomically, the increased adipose tissue seen with obese individuals is present within the pharyngeal structures resulting in lumen narrowing, which is particularly significant during inspiration (Murphy & Wong, 2013). Obese patients are also predisposed to obstructive sleep apnea (OSA) due to a combination of large tongues, upper airway narrowing, excessive upper airway soft tissue, and reduced pharyngeal dilator muscle function during periods of somnolence (Leong et al., 2018; Murphy & Wong, 2013). Additionally, obese individuals experience increased oxygen consumption, a widened alveolar-arterial gradient, higher respiratory rates, reduced lung volumes, higher minute ventilation, reduced total respiratory system compliance, and increased airway resistance compared to patients who are not obese (Murphy & Wong, 2013). Obese patients suffer from a modest decrease in total lung capacity and residual volume, and decreased expiratory reserve volumes (Cullen & Ferguson, 2012; Murphy & Wong, 2013). Increased fatty tissue on the body including the face, neck, breasts, thorax and abdomen serve to increase the potential for airway problems related to patient positioning, neck extension, bag and mask ventilation, tracheal intubation, oxygenation, and tracheotomy (Murphy & Wong, 2013). Direct laryngoscopy in the obese patient is further complicated by redundant oropharyngeal tissue, atlantoaxial joint limitation due to cervical and thoracic fat pads, and presternal fat deposits that inhibit movement of the laryngoscope and increase the difficulty of direct laryngoscopy; as a result of these physiological and anatomical differences, a BMI greater than 30 is an independent predictor of both difficult mask ventilation and tracheal intubation (Dority et al., 2011; Murphy & Wong, 2013). It is due to these factors that, during apnea following preoxygenation, the average time to reach an SpO_2 of 90% in patients with a normal body habitus was 6 minutes compared to only 2.7 minutes in the morbidly obese patient (Nimmagadda et al., 2016). All of the aforementioned factors put the obese patient at a significant increased risk for rapid desaturation following the onset of apnea.

Note again the importance of lung volumes when anesthesia is delivered, particularly during apnea. Of particular importance from an anesthesia standpoint is the significantly reduced FRC seen with the obese patient population (Jense et al., 1991; Murphy & Wong, 2013). In the supine position, FRC in obese adult males is approximately 1.9 liters compared to 2.6 liters in normal weight individuals (Jense et al., 1991). Even worse, obese patients experience a decrease in their FRC by approximately 50% following the induction of anesthesia (and compared to preanesthetic values) as compared to only a 20% decrease in non-obese patients (Murphy & Wong, 2013). Preoxygenation in obese patients is complicated not only by a reduced

FRC, but also the compression of the thorax by surrounding tissues and the cephalad displacement of the diaphragm in the supine position (Tanoubi et al., 2009). All of these factors are important variables to consider when providing anesthetic care to the obese patient population.

Obesity and the Difficult Airway

As previously discussed, obese patients pose unique airway challenges to anesthesia providers. To ensure patient safety throughout the perioperative period, it is vital for anesthesia providers to realize the potential for respiratory compromise in all patients yet understand that the risk for respiratory compromise is significantly increased in the obese patient population. The maintenance of oxygenation during airway management is of upmost importance in the perioperative period. Not only is patient safety at risk, but the history of litigation due to airway management speaks volumes about its importance. A closed claim database consists of a summary of closed anesthesia malpractice claims from anesthesia liability insurers throughout the United States (Posner, 2001). Between the years 1990 to 2007, adverse respiratory events accounted for 17% of the most damaging events in the closed-claim database of the American Society of Anesthesiologists (ASA) and 31.8% of the closed-claims database of the American Association of Nurse Anesthetists (AANA) (Pratt & Miller, 2016). 27% of all adverse respiratory events in the ASA database were attributed to difficult airway management, with 67% occurring on induction (Pratt & Miller, 2016). Moreover, after reviewing major complications of airway management, the United Kingdom Fourth National Audit Project reported a fourfold increase in the risk of serious complications associated with airway management of morbidly obese patients as compared to patients who are not obese; likewise, obese patients are more likely to suffer from airway problems during anesthesia than patients who are not obese, with the risk being up to four times as great with severe obesity (Cullen & Ferguson, 2012; Murphy & Wong, 2013). Juvin et al. (2003) studied the incidence of difficult tracheal intubation in obese patients and found that the rate of difficult intubation was 15.5% in obese patients (BMI ≥ 35) compared to 2.2% in non-obese patients (BMI <30). As obesity increases, the safe apnea period decreases (Jense et al., 1991). This fact alone should put anesthesia providers on high alert when caring for an obese patient.

While obesity is associated with various anatomical and physiological changes, common comorbidities often seen with obese patients put them at even more risk for respiratory compromise in the perioperative period. Obesity is the most important risk factor for developing obstructive sleep apnea (OSA) and the incidence of OSA and morbid obesity is estimated to be somewhere between 40 to 80% (Leong et al., 2018). From an anesthesia provider's perspective, it is vital to realize that as the prevalence of obesity continues to increase, so too will the prevalence of surgical patients who are both obese and suffer from OSA, whether it is officially diagnosed or not. This is an important consideration as OSA is associated with a higher incidence of both difficult mask ventilation and difficult laryngoscopy (Leong et al., 2018). This combination can lead to the most dreaded scenario in anesthesia: cannot intubate, cannot ventilate, which can be a significant patient safety threat and may result in significant morbidity and mortality (Leong et al., 2018). From another perspective, in all patients that were difficult to intubate, the incidence of OSA was 66% (Leong et al., 2018). Thus, it is vital for anesthesia providers to perform a thorough preanesthetic assessment and be prepared when caring for this vulnerable patient population.

Adverse Effects of Desaturation

As previously discussed, obese individuals are at increased risk for respiratory compromise and rapid desaturation due to anatomic and physiological changes as well as concurrent diseases commonly associated with obesity, including OSA. Adverse effects of desaturation below 70% include dysrhythmias, hemodynamic decompensation, hypoxic brain injury, and death (Weingart & Levitan, 2011). Periods of desaturation below 90% is associated with the potential for atelectasis, ventilation/perfusion mismatch, hypoxemia, and cardiac arrest (Langeron et al., 2014; Pavlov et al., 2017). Similarly, during rapid sequence induction, severe hypoxemia is associated with dysrhythmias, cardiac arrest, hypoxic brain injury, and death (Grude et al., 2018). In the following paragraphs, techniques will be described that have shown to help prevent the rapid desaturation often experienced by obese patients. These techniques can aid the anesthesia provider in the quest to keep this patient population free from the adverse effects of desaturation discussed above.

Apneic Oxygenation

Apneic oxygenation can be provided via many techniques and has been used successfully by emergency physicians, anesthetists, and EMTs to increase the safe apnea time in a variety of patients including pediatric, trauma, obstetric, and obese patients. Although apneic oxygenation techniques can be provided in a multitude of environments with a variety of patient populations, the purpose of this paper is to focus on its use with the obese patient population, or those with a BMI greater than or equal to 30. But first, what is apneic oxygenation?

When a patient is rendered apneic during anesthetic induction, the lung's alveoli continue to exchange oxygen and carbon dioxide. During apnea, alveoli will continue to see oxygen diffuse across the alveolar capillary membrane and carbon dioxide will continue to diffuse into the alveoli until oxygen stores are depleted (Brown, 2015). Even in the absence of diaphragmatic movement or lung expansion, alveoli continue to consume oxygen, and approximately 250 milliliters of oxygen per minute will move from the alveoli to the bloodstream when a patient is apneic; conversely, carbon dioxide moves into the alveoli during apnea at a rate of 8 to 20 milliliters per minute (Weingart & Levitan, 2011). The difference in oxygen and carbon dioxide movement causes the net pressure within the alveoli to be sub-atmospheric; as high partial pressures of oxygen are administered in the pharynx by apneic oxygenation techniques compared to the low partial pressure of oxygen in the alveoli, the pressure gradient created cause the gases in the pharynx to diffuse passively into the alveoli, further oxygenating them (Brown, 2015; Weingart & Levitan, 2011). This phenomenon is called apneic oxygenation and it permits the maintenance of oxygenation even when spontaneous or manually administered ventilations are not present (Weingart & Levitan, 2011). With optimal conditions, PaO_2 can be maintained at around 100 mmHg for up to 100 minutes without the anesthetist administering a breath or the patient taking any spontaneous breaths (Weingart & Levitan, 2011). Now, a little more history on apneic oxygenation.

Apneic oxygenation is not a new concept and it is important to note that apneic oxygenation may be referred to in different ways in clinical practice. Other terms referring to apneic oxygenation include apneic diffusion oxygenation, diffusion respiration, nasal oxygenation, and mass flow ventilation (Weingart & Levitan, 2011). As far back as 1959 was a study where eight patients undergoing elective procedures were sedated, paralyzed and subsequently intubated. They passively received oxygen despite no ventilations, and their duration of apnea lasted between 30 and 55 minutes; additionally, all of the individuals' oxygen saturation remained between 98 and 100% in the study (Brown, 2015). A variety of care providers use apneic oxygenation techniques, including neurocritical care physicians and neurologists who use it to prevent desaturation while brain dead examinations are performed; other procedures require apneic oxygenation techniques to prevent oxygen desaturation, including bronchoscopies and otolaryngeal procedures (Weingart & Levitan, 2011). Below the techniques of apneic oxygenation are discussed as well as past studies corroborating its benefits in the obese patient population.

Significant literature on apneic oxygenation has been published in the last ten to fifteen years both in the United States and abroad in journals of varying specialties, including emergency room physicians, anesthesia providers, and EMTs. Databases for the literature review included CINAHL Plus, Emcare, Google Scholar, Proquest Nursing and Allied Health, and PubMed. Initially, search criteria included keywords that were broad in nature but later became very specific to the DNP project at hand. Broad keywords included obese, obese patient, obesity, safe apnea, and airway management. The more specific keywords searched included apneic oxygenation (variable spelling includes apnoeic oxygenation), safe apnea (apnoea) period, passive oxygenation, and NODESAT. Primary research, systematic reviews of controlled trials, and meta-analysis were reviewed for further evidence and data related to apneic oxygenation. In addition to searching several databases, primary research was identified at the reference list of articles and assisted with gaining a firsthand account of research cited in the articles. Following the search for literature, each article was reviewed for its relevancy and supportive characteristics for the topic at hand.

Apneic Oxygenation in Clinical Practice

As previously stated, apneic oxygenation techniques have a place in a variety of clinical settings and patient populations. The purpose of this DNP Project, however, focused on apneic oxygenation techniques in the obese patient population. A study by Gaszynski (2019) assessed the use of continuous nasal positive airway pressure with a fresh gas flow of 12 liters per minute of 100% oxygen and regulation of airway pressure at 15 centimeters of water after anesthetic induction of 20 patients with a BMI greater than 50 (Gaszynski, 2019). The study found that every patients' SpO_2 remained greater than 94% during the entire apneic period, which lasted six minutes until they were intubated so as not to further delay surgery (Gaszynski, 2019). Following intubation, the mean end-tidal carbon dioxide was 40 mmHg, and the use of the continuous nasal oxygen did not compromise the effectiveness of videolaryngoscopy and subsequent tracheal intubation (Gaszynski, 2019). In patients in whom apneic oxygenation techniques are employed, not only are the mean oxygen saturation levels increased, but the time to desaturation is also prolonged. Ramachandran et al. (2010) performed a randomized controlled trial of 30 obese males undergoing general anesthesia. 15 patients received oxygen via nasal prongs at five liters per minute during preoxygenation and induction of anesthesia while 15 patients received no oxygen (Ramachandran et al., 2010). They found that maintenance of an SpO_2 greater than or equal to 95% in the group receiving oxygen was significantly longer than those who did not receive oxygen (5.29 +/- 1.02 minutes versus 3.49 +/- 1.33) (Ramachandran et al., 2010). Additionally, six patients who received oxygen had persistent SpO_2 levels greater than or equal to 95% as compared to only one patient in the group who did not receive oxygen (Ramachandran et al., 2010). Moreover, the lowest SpO_2 in the group who received oxygen was greater than those who did not (94.3 +/- 4.4% versus 87.7 +/- 9.3%) (Ramachandran et al., 2010).

A randomized controlled trial by Wong et al. (2019) studied 40 obese patients with a BMI greater than or equal to 40 who were undergoing elective procedures that required tracheal intubation. They found that the safe apnea time was 40% longer (76 seconds) in patients who received high-flow nasal oxygenation versus patients who received conventional facemask oxygenation during anesthetic induction (Wong et al., 2019). High-flow nasal oxygenation also resulted in a higher minimum SpO_2 (Wong et al., 2019). Baraka et al. (2007) studied 34 patients with a BMI greater than 35 undergoing elective surgery. Following preoxygenation and during the onset of apnea, a 10 French nasopharyngeal catheter was inserted in all patients with 17 patients receiving nasopharyngeal oxygen insufflation at an oxygen flow of five liters per minute and 17 patients receiving no oxygen (Baraka et al., 2007). Apnea continued until either four minutes had passed or until SpO_2 fell to 95% (Baraka et al., 2007). In the patients who did not receive oxygen via the nasopharyngeal catheter, all desaturated to 95% with a mean time of 145 seconds (Baraka et al., 2007). In the patients who did receive oxygen via the nasopharyngeal catheter, 16 of the 17 patients remained at an SpO_2 of 100% for up to four minutes; the one patient (BMI of 65) who did not remain at 100% desaturated to an SpO_2 of 95% after 153 seconds (Baraka et al., 2007).

Heard et al. (2017) studied 40 patients with a BMI ranging from 30 to 40. Twenty patients received buccal oxygen via a modified Ring-Adair-Elwyn tube applied to the left internal cheek whereas 20 patients in the control group did not (Heard et al., 2017). Patients who received buccal oxygenation were less likely to exhibit an SpO_2 of less than 95% during apnea as compared to patients who did not receive buccal oxygen (Heard et al., 2017). Moreover, their median time of maintaining an SpO_2 greater than 95% during apnea was prolonged as compared to the group who did not receive oxygen (Heard et al., 2017). A similar randomized controlled trial by Toner et al. (2019) studied buccal oxygen administration in nonobese patients and found that patients who received apneic oxygenation via a buccal device exhibited higher tracheal oxygen concentrations during apnea and had a prolonged median apnea time with an SpO_2 greater than 94% (750 seconds versus 447 seconds in patients not receiving buccal oxygen) (Toner et al., 2019).

Wong et al. (2017) performed a narrative review- among which included 12 operating room studies- of the effectiveness of apneic oxygenation. Of the 12 studies, eight were randomized-controlled trials (Wong et al., 2017). All studies showed that apneic oxygenation decreased the incidence of desaturation as well as prolonged the duration to desaturation (Wong et al., 2017). A systematic review and meta-analysis of 10 studies with a total of 2,322 patients found that apneic oxygenation was beneficial and reduced the incidence of oxygen desaturation (Tan et al., 2017). Numerous other studies have yielded similar results to the ones above and illustrate how apneic oxygenation has prolonged the safe apnea time in both emergency intubations and in the obese patient population.

Current Guidelines

Guidelines related to apneic oxygenation do not currently exist specifically related to the obese patient population. However, the Obstetric Anaesthetists' Association and Difficult Airway Society, both based out of the United Kingdom, developed the first national guidelines in 2015 for the management of both difficult and failed tracheal intubation in obstetric patients undergoing general anesthesia (Mushambi et al., 2015). The first algorithm provides a framework for the administration of a safe general anesthetic to this patient population and reminds the anesthesia provider to consider the utilization of nasal oxygenation via a nasal cannula at five liters per minute following anesthetic induction (Mushambi et al., 2015). As further research evolves, more guidelines concerning apneic oxygenation techniques in clinical practice will be published.

Gaps in the Literature

While the current research regarding apneic oxygenation techniques shows its many benefits in several patient populations, a few gaps in the current literature exists. For example, levels of oxygen flow vary considerably among different research studies, with some studies examining the efficacy of apneic oxygenation techniques with five liters of oxygen per minute like that of Ramachandran et al. (2010) and Baraka et al. (2007), and some researchers using 15 liters of oxygen per minute (Gleason et al., 2017). Additionally, while some disease states such as shunting and primary respiratory compromise have been singled out to cause apneic oxygenation techniques to be ineffective, medical conditions (such as anaphylaxis) and other potential comorbidities have little research on whether or not apneic oxygenation techniques would be efficacious to patients suffering from these health conditions (Gleason et al., 2017). Thus, it is vital for continued research into apneic oxygenation and its effects on individuals with various medical conditions and comorbidities.

Factors Improving Apneic Oxygenation

While NODESAT has shown to be beneficial in the obese population, other techniques should be used in conjunction with apneic oxygenation to increase the mean SpO_2 while increasing the time to desaturation. These factors are known as the four “Ps” and include: positioning, preoxygenation, positive end-expiratory pressure (PEEP), and patent airway.

Positioning

One of the factors that should be used in conjunction with apneic oxygenation techniques in the obese patient population is proper positioning during preoxygenation and induction of anesthesia. Studies show that severely obese patients experience significantly higher oxygen tensions and, ultimately, a significantly increased safe apnea period when placed in a 25-degree head up position as compared to a flat supine position (Dixon et al., 2005). Studies by Altermatt et al. (2005) and Frerk et al. (2015) support this practice in obese adults as well. In the flat supine position, the adipose tissue in the chest wall, abdominal wall, and abdomen compress the thoracic cage, diaphragm, and lungs of obese patients, with the subsequent cephalad displacement of the diaphragm further reducing their FRC and increasing airway resistance (Altermatt et al., 2005; Dixon et al., 2005). Ideally, the external auditory meatus should be on the same horizontal plane as the sternal notch in the head-elevated position (Rezaie, 2014). This position improves both airway patency and respiratory mechanics in the obese patient and facilitates apneic oxygenation techniques during the apneic period (Frerk et al., 2015). Proper positioning is a vital factor to consider during the anesthetic induction of obese adults.

Preoxygenation

As discussed earlier, adequate preoxygenation is vital to maximize oxygen storage in the lungs prior to apnea, particularly in the obese patient population who suffer from a decreased FRC. Obese patients should be pre-oxygenated with 100% inspired oxygen during either tidal volume breathing for three minutes (minimum) or eight vital capacity breaths over a period of one minute with maximal inhalation and exhalation, or until end-tidal oxygen is greater than 90% (Law et al., 2013; Weingart & Levitan, 2011).

Positive End-Expiratory Pressure

Along with positioning and preoxygenation, positive end-expiratory pressure (PEEP) can increase the efficacy of apneic oxygenation. By increasing the volume of gas that remains in the lungs at end-expiration, PEEP allows for sustained alveolar distention and improves gas exchange (Weingart & Levitan, 2011). PEEP prevents absorption atelectasis that can be caused by breathing in a high fraction of inspired oxygen, and it should be noted that patients remaining at an oxygen saturation of 91-95% despite receiving high FiO_2 levels are at risk of critical desaturation during emergency tracheal intubation (Weingart & Levitan, 2011). These patients may benefit from adding PEEP during preoxygenation and prior to the administration of muscle relaxants (Weingart & Levitan, 2011).

The Patent Airway

While NODESAT can be employed for a variety of patients, there are some diseases and physiological states where NODESAT would prove ineffective in clinical practice. For one, apneic oxygenation requires a patent airway in order for the passive flow of oxygen to reach the hypopharynx and enter the trachea (Weingart & Levitan, 2011). Likewise, it is vital to ensure that following the administration of sedatives and muscle relaxants, the posterior pharyngeal structures and tongue refrain from occluding the passive flow of oxygen into the trachea (Weingart & Levitan, 2011). Techniques such as head elevation, chin lift, and jaw thrust can accomplish a patent airway in the majority of patients, along with a nasal trumpet or oropharyngeal airway in patients requiring it (Weingart & Levitan, 2011). Obese patients and/or patients with sleep apnea may require a combination of jaw distraction, lifting of submandibular soft tissue, and a nasopharyngeal or oropharyngeal airway (Weingart & Levitan, 2011). These are important considerations when NODESAT is employed in the clinical setting.

Final Recommendations

Many factors can assist with optimizing the safe apnea period and apneic oxygenation techniques when tracheal intubation is attempted in the obese patient, including positioning, proper preoxygenation, PEEP, and maintenance of a patent airway. The use of a nasal cannula is the technique of choice when providing apneic oxygenation and should remain on the patient during both preoxygenation and the induction of general anesthesia until the endotracheal tube is safely secured (Rezaie, 2015; Weingart & Levitan, 2011). NODESAT has been shown to extend the safe apnea time in the obese patient population and in patients with a difficult airway and should be employed by delivering up to 15 liters per minute of oxygen through a nasal cannula during the apneic period (Frerk et al., 2015). While this may be uncomfortable for an awake patient, it should be noted that providing oxygen at five liters per minute via a nasal cannula both prior to and during preoxygenation should be employed on this patient population (Mushambi et al., 2014); the flow can be turned up to 15 liters per minute when the patient becomes apneic. After the patient is successfully intubated, the flow of oxygen should be turned off and the nasal cannula removed.

According to Weingart and Levitan (2011), critically ill patients experiencing high degrees of shunting will likely see no benefit when apneic oxygenation techniques are used alone. Though employment of apneic oxygenation techniques has prevented or delayed desaturation in all patients, it may be ineffective in patients with primary respiratory failure (Gleason et al., 2018). With the data supporting its use in the obese patient population, one has to question why apneic oxygenation techniques are not being integrated in operating rooms and emergency departments across the world (Gleason et al., 2018). Vlok et al. (2018) concluded that it is reasonable to employ the routine use of apneic oxygenation techniques during intubation. With this in mind, next comes the question of whether apneic oxygenation techniques should be employed by anesthesia providers for all obese patients. King and Jagannathan (2018) studied the use of videolaryngoscopy during routine tracheal intubation in obese adults and suggested that apneic oxygenation techniques become the standard of care for obese adults. As further research on the subject arises, apneic oxygenation techniques for obese patients may become a standard of care extensively used in future anesthetic practice.

Summary of Supporting Evidence

Research supports the use of apneic oxygenation techniques in individuals at high risk for rapid desaturation following the induction of anesthesia. Obese patients are no exception. Obese adults have reduced lung volumes, reduced respiratory system compliance, and increased airway resistance that causes them to be an independent predictor of both difficult mask ventilation and difficult laryngoscopy (Murphy & Wong, 2013). Additionally, difficult airway management during induction of anesthesia makes up a significant proportion of the closed-claim database of the ASA and AANA (Pratt & Miller, 2016). Anesthesia providers are more likely to experience difficulty in intubating an obese individual as compared to a patient who is not obese (Juvin et al., 2003). NODESAT and other apneic oxygenation techniques call for the delivery of oxygen via a nasal cannula during preoxygenation and anesthetic induction until tracheal intubation is successful. Guidelines recommending the consideration of nasal oxygenation for difficult and failed intubation of obstetric patients was recently added to the Difficult Airway Society and Obstetric Anaesthetists' Association guidelines as apneic oxygenation techniques have shown to prolong the safe apnea time and heighten the minimum SpO_2 level in obese patients undergoing general anesthesia (Mushambi et al., 2015; Wong et al., 2019). Evidence supports the use of NODESAT as a standard of care for obese adults undergoing general anesthesia with tracheal intubation.

Chapter 3: Project Design

Methodology

Pathman's Pipeline Model was used in the planning, implementation, and evaluation phases of this DNP Scholarly Project. The model assisted in facilitating the evaluation of the aims and outcomes previously stated by the project manager. Steps in completing the DNP Project included reviewing of literature, identifying key stakeholders to enable a successful intervention, and evaluating the intervention as it related to the aims of the project. Through the use of the model, the project was able to be developed, a successful intervention was created, and aims were achieved as a result.

A demographic questionnaire was distributed to members of the INANA to allow the project manager to better analyze participant work history, experience, employment status, and anesthesia practice type (see Appendix C). Additionally, both the pre and post-test contained the same questions to allow the project manager to objectively assess knowledge gain following the educational PowerPoint (see Appendix D and E). The pre and post-test questions were reviewed by anesthesia experts both within USF and outside of the University for content validity.

Project Design

The project design appropriate for this DNP Scholarly Project was a Quality Improvement (QI) Project designed to increase INANA members' knowledge and, ultimately, use of the NO DESAT technique in obese patients undergoing endotracheal intubation.

Ethical Considerations

The project manager successfully completed CITI Training in NURS 638: Methods for Evidenced Based Nursing Practice during the spring semester of 2020. CITI training provided an additional measure for maintaining ethical standards throughout the planning, implementation, and evaluation phases of this DNP Scholarly Project (see Appendix F-J). A letter of support from INANA President Dr. Greg Louck was obtained and granted the project manager permission to implement the project with INANA members without the need for additional IRB approval outside of that required by USF (see Appendix K).

Project Schedule

The timeline for this project occurred from January 2020 to June 2021, when the project reached completion. Planning for the DNP Project and communicating with the stakeholders of the project occurred throughout the year of 2020. Completion of the DNP Project Proposal occurred during late August to mid-September of 2020, with official submission to the USF IRB occuring on September 21, 2020. Official USF IRB approval was granted on October 12, 2020 (see Appendix L). The implementation of the project occurred from January 11, 2021 to January 25, 2021, with data collection and analysis occurring the following week (January 26-February 7) and through the spring semester of 2021. Dissemination of project findings to USF faculty, staff, and peers occurred in June 2021.

Implementation Methods

Implementation methods involved in this DNP Scholarly Project focused on increasing CRNA/SRNA knowledge and use of the NO DESAT technique on obese adults undergoing endotracheal intubation. Prior to the distribution of the survey to INANA members, the project manager emailed all surveys and the PowerPoint presentation to Kim Williams, INANA Chapter Administrator. To ensure privacy and anonymity for survey participants, the project manager did not have access to INANA members' emails, and all correspondence with members was done through Kim Williams. Through email, Kim Williams distributed the pre-test, demographic questionnaire, PowerPoint presentation, post-test and survey to INANA members. Participants were made aware in the email that they had two weeks to complete all parts of the DNP Project (January 18, 2021 to February 1, 2021) if they were willing to participate. First, participants were asked to fill out a demographic questionnaire (Appendix C) with six questions followed by a ten-question pre-test (Appendix D) to assess for baseline knowledge of the NO DESAT technique. Next, participants were asked to read the 19-slide PowerPoint presentation (Appendix M) regarding apneic oxygenation and the NO DESAT technique. Following the PowerPoint presentation, respondents were asked to fill out a ten-question post-test which included the same questions as the pre-test (Appendix E). Finally, respondents were asked to fill out a survey regarding the PowerPoint presentation and a self-assessment of their confidence in using the technique in clinical practice (Appendix E). Completed responses to the questionnaires, surveys, and pre/post-tests were collected in Microsoft Forms and sent to the project manager's University of Saint Francis email. To ensure the secure storage of participant responses to the surveys, questionnaires, and pre/post-tests, all data was collected in aggregate and stored on the project manager's password-protected personal computer until September 2021, when all data will be erased through the use of a software application designed to remove computer data securely. Additionally, data was deidentified as each respondent was assigned a unique numeric identifier through Microsoft Forms.

The project manager chose a PowerPoint presentation that was 19 slides in order to provide concise information on the topic while also respecting the time constraints of both CRNAs and SRNAs. Learning objectives that were listed on the PowerPoint presentation and were included in the teaching plan consisted of the following:

Following the PowerPoint presentation, the learner will be able to:

1. Define the acronym NO DESAT.

2. Explain the goal of apneic oxygenation during anesthetic induction.
3. Define the safe limit of apneic oxygenation.
4. Summarize how to perform the NO DESAT technique during anesthetic induction.
5. Articulate techniques that should be used in conjunction with apneic oxygenation techniques to increase the safe apnea time.
6. Identify the populations that are and are not candidates for apneic oxygenation.

Measures/Tools/Instruments

Prior to the implementation phase, the project manager defined three aims and associated outcomes in order to objectively assess whether or not CRNAs and SRNAs benefitted from the project. The aims and outcomes defined by the project manager included the following:

- Aim 1: Evaluate Certified Registered Nurse Anesthetists' (CRNAs) and Student Registered Nurse Anesthetists' (SRNAs) baseline knowledge, knowledge gain, and perceived knowledge following the educational in-service regarding apneic oxygenation and its benefits in the specified patient population.
    - Outcome/Indicator 1a: Following the education session, CRNA and SRNA mean scores on the post knowledge questionnaire will increase by 15% compared to the baseline knowledge questionnaire.
    - Outcome/Indicator1b: At least 80% of all CRNAs and SRNAs will self-report that their perceived knowledge of apneic oxygenation has been enhanced following the education session.

- Aim 2: Evaluate CRNAs' and SRNAs' perceived barriers to utilizing apneic oxygenation techniques in the clinical setting and CRNAs' and SRNAs' confidence in addressing the identified barriers in clinical practice.
    - Outcome/Indicator 2a*:* Following the education session, CRNAs and SRNAs will identify the most common barrier they foresee to utilizing apneic oxygenation techniques in the clinical setting.
    - Outcome/Indicator 2b: Following the education session, at least 60% of CRNAs and SRNAs will rate themselves as feeling confident in addressing the perceived barriers to the utilization of apneic oxygenation techniques in the clinical setting.
- Aim 3: Increase both CRNAs' and SRNAs' confidence and thereby increase the frequency of use of apneic oxygenation techniques during endotracheal intubations in the clinical setting.
    - Outcome/Indicator 3a: Following the education session, at least 75% of CRNAs and SRNAs will self-report having the confidence to employ apneic oxygenation techniques in clinical practice.
    - Outcome/Indicator 3b: Following the education session, at least 75% of CRNAs and SRNAs will self-report being likely to use apneic oxygenation techniques in their future clinical practice.

The demographic questionnaire sent to members of the INANA allowed the project manager to better analyze participant work history, experience, employment status, and anesthesia practice type (see Appendix C). Additionally, both the pre and post-test contained the same questions to allow the project manager to objectively identify knowledge gain following the educational PowerPoint (see Appendix D and E). The pre and post-test questions were reviewed by anesthesia experts both within the University of Saint Francis and outside of the University for content validity. Mean responses from the pre-test were compared to mean responses from the post-test to assess for knowledge gain following the educational PowerPoint. Additionally, questions on the demographic questionnaire assisted the project manager in assessing whether or not participants had ever utilized NO DESAT in clinical practice, while questions on the post-intervention survey assisted the project manager in evaluating whether or not participants were more likely to use the technique in practice after having been educated on the topic. All data analysis and evaluation were completed anonymously through an online data evaluation system, SPSS.

Evaluation Plan

The methods for evaluating the data included utilizing all responses on the pre-test, demographic questionnaire, post-test, and post-intervention survey to perform a comparative analysis following the educational PowerPoint presentation.

Data Sources/Methods for Collection of Data

Microsoft Forms was a data source used for the implementation and evaluation of the DNP Project, which also allowed participants to voluntarily sign the informed consent sheet and complete all parts of the project in an anonymous and confidential fashion. Responses of the pre-test, post-test, survey and questionnaire were collected from Microsoft Forms into an excel spreadsheet that was later transferred to SPSS to allow for data evaluation. All data collected was stored on the project manager’s password-protected computer.

Data Analysis Plan

As an increase in the knowledge of the NO DESAT technique and its benefits in the obese patient population was one of the aims of this quality improvement project, an assessment of knowledge gain following the educational PowerPoint was performed with a comparative analysis of both the pre and post-educational test results. Another aim of the project was to evaluate providers' perceived barriers to using the technique in practice and CRNA/SRNA confidence in addressing barriers in the clinical setting. These factors were evaluated through the post-educational questionnaire, where CRNAs and SRNAs were asked to pick via multiple-choice question which barrier they most foresee to utilizing the technique in practice. A space was also provided for the participants to fill in what they perceive as additional barriers to utilizing NO DESAT in the clinical setting. The results of a multiple-choice question and the most commonly listed fill-in-the-blank answers were analyzed and written in the DNP Project manuscript. While addressing the most common barriers to utilizing the technique in clinical practice is beyond the scope of this project, it could be a potential future DNP Scholarly Project or administrative/anesthesia provider project at a particular facility to better facilitate the use of NO DESAT in the clinical setting.

The project manager was responsible for logging and entering data into SPSS for result analysis, which occurred from February 2, 2021 through February 14, 2021. It is important to note that all data was collected in aggregate and participant identity was protected with a unique numerical identification code to ensure anonymity and confidentiality.

Dissemination Plan

Disseminating project findings to key stakeholders following data analysis and evaluation was vital. Results of the project were dispersed to INANA members after the project manager emailed the results to Kim Williams. Additionally, the findings of this DNP Scholarly Project were formally disseminated to the Nurse Anesthesia Program faculty and nursing doctoral faculty along with fellow SRNAs from the University of Saint Francis. Included in the dissemination was a PowerPoint presentation outlining the project aims and outcomes, findings, and the project manager's conclusions. The formal presentation to the above-mentioned individuals occurred in June 2021. During the dissemination of the project findings, the project manager led a discussion of the future of the project topic, including how facilities and CRNAs/SRNAs can increase the use of NO DESAT in their clinical setting.

Chapter 4: Results and Outcomes Analysis

Data Collection Techniques

Following institutional review board approval required by the University of Saint Francis, the project manager coordinated a timeline for project implementation with INANA Chapter Administrator Kim Williams and INANA President Dr. Greg Louck. The data collection phase of the project occurred from January 9, 2021 through January 25, 2021. Because the project manager did not receive INANA members' email addresses, Kim Williams emailed the components of the project to INANA members. As stated in the project directions, the data to be collected included a pre-intervention demographic questionnaire/survey, a post-intervention survey, and a pre and post-test to evaluate for knowledge gain following the intervention. Informed consent was obtained electronically and was required to be completed prior to participation in the project. The demographic questionnaire/survey focused on collecting demographic and work-related data of participants to assist in data analysis. For example, participants were asked to respond whether they were a CRNA or SRNA to assist in gauging the differences between the groups' pre and post-test scores as well as evaluating the differences the groups had in their self-report of barriers to implementing the technique in practice. A post-intervention survey was used to assess participant self-report of whether or not they were likely to use the technique in practice along with assisting in the identification of some of the barriers to implementing the technique in the clinical setting. Additionally, three Likert scale questions were used in the post-survey to evaluate the effectiveness of the PowerPoint in facilitating knowledge gain as well as participant confidence in using the technique in their current practice.

All data was collected electronically through Microsoft Forms, which is a free online application that allows for the creation of surveys and quizzes. All data was collected anonymously through Microsoft Forms during the two-week implementation period and was exported first to Microsoft Excel followed by IBM Statistics SPSS Version 26 to allow for data analysis.

Measures/Indicators

According to Kim Williams, the invitation to participate in the DNP Project was distributed to all 553 members of the INANA. Because the project manager was a member of the INANA and did not participate in the project, a total of 552 members remained who were potential respondents. At the conclusion of the project implementation, there were 28 participants who responded to the pre-intervention survey/test (5.07% response rate) and 24 participants who responded to the post-intervention survey/test (4.35% response rate). Four participants completed the pre-intervention requirements without completing the post-intervention requirements. Because both components were required for inclusion in the project, the pre-intervention responses from the four participants were omitted during data analysis. Thus, there were a total of 24 respondents (n=24) who were included in the pre and post-intervention data analysis.

Of the 24 respondents, 12 self-identified as CRNAs (50%) and 12 self-identified as SRNAs. Of the CRNAs, five had 21 years or more experience (41.67%), two had 11-20 years of experience (16.67%), three had six to ten years of experience (25%), and two had less than one year of experience (16.67%). Of the SRNAs, nine had less than one year of experience (75%), and three had 1-2 years of clinical anesthesia experience (25%). All but one respondent (CRNA) indicated that they worked at a facility where they regularly performed endotracheal intubations. When asked how many times the respondent had employed apneic oxygenation techniques during the induction of anesthesia, 13 (54.17%) indicated zero times, five respondents (20.83%)

indicated one to five times, one respondent (4.17%) indicated six to ten times, and five respondents (20.83%) indicated eleven times or more.

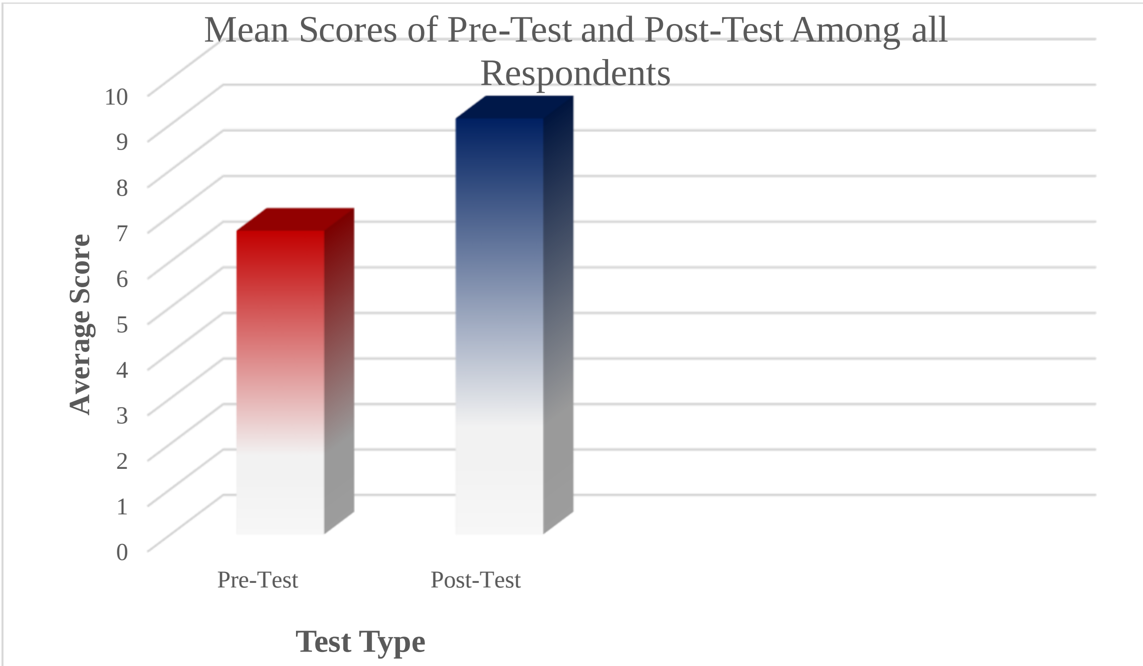
Table 4.1 below differentiates between the hypothesis and null hypothesis of this DNP Project.

Table 4.1 Hypothesis and Null Hypothesis	
Hypothesis	Following the educational PowerPoint, there was a statistically significant difference in scores between the pre and post-tests.
Null Hypothesis	Following the educational PowerPoint, there was no statistically significant difference in pre and post-test results.

To analyze the difference between the mean of the pre-intervention test and post-intervention test and its significance, a paired sample t-test was performed using the IBM Statistics SPSS Version 26 Software. The mean score of the pre-intervention test (n=24) was 6.67 and the mean score of the post-intervention test (n=24) was 9.13. (Of note, the maximum score available for each test was ten.) This resulted in a mean score difference of 2.458 and a percent increase in post-test scores of 36.85% compared to pre-test scores. The p-value resulted in a significance value of .000, which is less than 0.05 signaling the ability to reject the null hypothesis and conclude that the intervention resulted in a significant difference between pre and post-test scores. Appendix N shows the SPSS analysis of pre and post-test averages for all respondents.

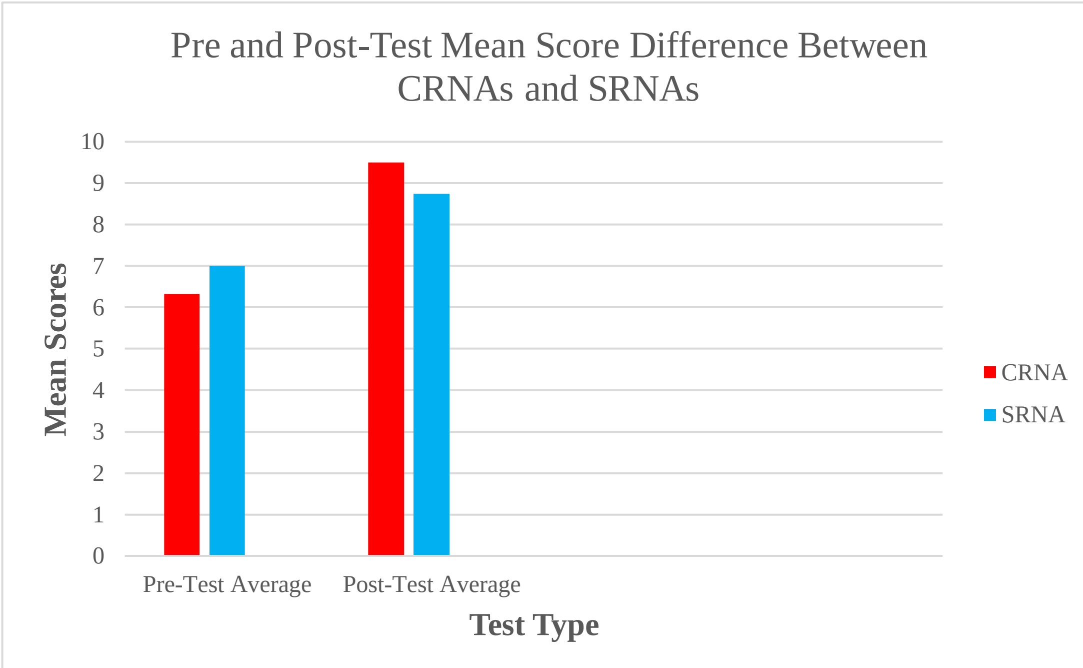
Figure 4.1 is a bar chart depicting the difference in mean scores of both pre and post-tests of all respondents.

Figure 4.1



While there was a statistically significant difference in pre and post-test results following the educational PowerPoint, there was not a statistically significant difference between CRNA and SRNA mean knowledge gain following the educational PowerPoint. An independent samples t-test showed that the pre-test score average for CRNAs was 6.33 compared with SRNA average of 7.00. The post-test scores of CRNAs averaged 9.50 compared to SRNAs average of 8.75. Appendix O shows the SPSS output of the difference between pre and post-test scores among CRNAs and SRNAs, along with the visual representation of the difference of the two with a bar graph in Figure 4.2.

Figure 4.2

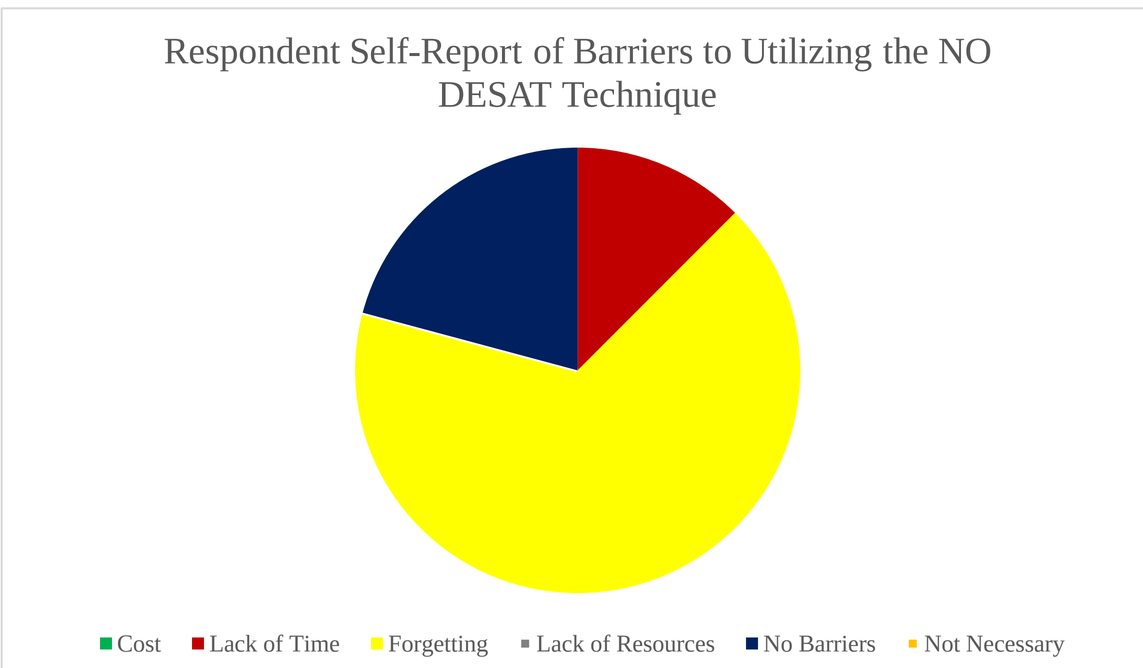


The post-educational survey assessed for participant self-report of their likelihood of using the technique in practice as well as barriers to utilizing the technique in the clinical setting. Using a Likert scale, participants were asked their confidence in employing the technique in the clinical setting following the PowerPoint Presentation (see question 11 in Table 4.2 below). Sixteen participants (66.67%) stated they "strongly agreed" and eight participants (33.33%) stated that they "agreed" that they had the confidence to employ the technique. No participants selected "neutral", "disagree", or "strongly disagree" to this question. After asking participants whether or not they will use the technique after viewing the educational PowerPoint, 11 participants (45.3%) "strongly agreed" they would, nine participants (37.5%) "agreed" they would, two participants (8.33%) were "neutral", and two participants did not respond (see question 12 in Table 4.2 below). The last Likert scale question asked participants if the PowerPoint Presentation enhanced their knowledge of apneic oxygenation and the NO DESAT technique (question 13, Table 4.2). Seventeen participants (70.83%) “strongly agreed” to this statement, 5 participants (20.83%) “agreed” to this statement, and two participants (8.33%) were neutral.

Table 4.2 Questions on the Post-Educational Survey	
Question 11	Following the PowerPoint Presentation regarding apneic oxygenation and NO DESAT, I have confidence employing the technique in clinical practice: a. Strongly agree (66.7%) b. Agree (33.33%) c. Neutral d. Disagree e. Strongly disagree
Question 12	Following the PowerPoint Presentation, I will use AO techniques in patients at high risk for rapid desaturation during apnea. a. Strongly agree (45.3%) b. Agree (37.5%) c. Neutral (8.33%) d. Disagree e. Strongly disagree
Question 13	The PowerPoint Presentation enhanced my knowledge about apneic oxygenation and NO DESAT. a. Strongly agree (70.83%) b. Agree (20.83%) c. Neutral (8.33%) d. Disagree e. Strongly disagree
Question 14	Please indicate what you believe is the most significant barrier to the employment of AO techniques in clinical practice. a. Cost b. Lack of time (12.5%) c. Forgetting to do it in practice (66.67%) d. Lack of resources e. I do not believe it is a necessary technique to utilize in my practice f. There are no barriers (20.83%)

Question 14 of the post-intervention survey (see Table 4.2 above) asked participants to identify the most significant barrier to employing NO DESAT in the clinical setting. Five participants (20.83%) stated there were no barriers and three participants (12.5%) stated that lack of time was the most significant barrier to utilizing the technique in practice. The majority of respondents (16 or 66.67%) stated that "forgetting to do it in practice" was the most significant barrier to utilizing the technique in the clinical setting. No participant selected "cost", "lack of resources", or "I do not believe it is a necessary technique to utilize in my practice" as a barrier to implementation.

Figure 4.5



The final multiple-choice question on the post-intervention survey asked respondents whether or not they felt confident in addressing barriers to implementing NO DESAT in the clinical setting, 22 respondents (91.67%) replied "yes", one respondent (4.17%) replied "no", and one respondent did not answer.

Finally, respondents were asked to fill-in-the-blank any additional barriers they foresaw to utilizing the technique in the clinical setting. Table 4.3 below lists the responses.

Table 4.3	
Responses to fill-in-the-blank question 16 (Appendix E) regarding perceived barriers to implementing the technique in clinical practice.	*"Old dog and learning new tricks"* *"Perhaps cost – but I do not think this will be a significant barrier"* *"Time"* *"The clinical preceptor not wanting the student to perform it."* *"Beyond ramping and good pre-oxygenation, is this tech needed?"* *"Traditional old school practice"* *"As a student, I am subject to do what my preceptor wishes to do. I will suggest it in my anesthetic plan; however, I anticipate this being a barrier to my personal use of this technique."* *"Preceptors refusal, and resistance to change"*

Data Analysis Inferences

Data analysis of each question on the pre-intervention survey/quiz and post-intervention survey/quiz ultimately assisted the project manager in determining the effectiveness of the educational intervention as well as whether or not the project achieved its intended objectives. The following table lists the aims and outcomes/indicators from Chapter 1 of this DNP Project manuscript, with the ways the aims and outcomes were met highlighted below them in yellow.

Aim 1: To evaluate CRNAs and SRNAs baseline knowledge, knowledge gain, and perceived knowledge following the educational in-service regarding apneic oxygenation and its benefits in the specified patient population.
○ Outcome/Indicator 1a: Following the education session, CRNA and SRNA mean scores on the post knowledge questionnaire will increase by 15% compared to the baseline knowledge questionnaire. ○ CRNA and SRNA mean scores on the post-test increased by 36.85% as compared to the pre-test mean score.
○ Outcome/Indicator1b: At least 80% of all CRNAs and SRNAs will self-report that their perceived knowledge of apneic oxygenation has been enhanced following the education session.

◦ 22 out of 24 respondents, or 91.67% of respondents, either "agreed" or "strongly agreed" that the PowerPoint presentation enhanced their knowledge of apneic oxygenation techniques.
• Aim 2: To evaluate CRNAs' and SRNAs' perceived barriers to utilizing apneic oxygenation techniques in the clinical setting and CRNA and SRNA confidence in addressing the identified barriers in clinical practice.
◦ Outcome/Indicator 2a*:* Following the education session, CRNAs and SRNAs will identify the most common barrier they foresee to utilizing apneic oxygenation techniques in the clinical setting. ◦ The overwhelming majority of respondents stated that forgetting to perform the technique in practice was the most significant barrier to utilizing the technique. Additional barriers included lack of time, and several respondents listed that there were no barriers to employing the technique in the clinical setting.
◦ Outcome/Indicator 2b: Following the education session, at least 60% of CRNAs and SRNAs will rate themselves as feeling confident in addressing the perceived barriers to the utilization of apneic oxygenation techniques in the clinical setting. ◦ 91.67% of respondents stated "yes", that they did feel confident in addressing barriers to employing the technique in the clinical setting, and one participant did not answer the question. Only one out of 24 respondents (4.17%) indicated that he or she did not feel confident in addressing barriers to employing apneic oxygenation techniques in the clinical setting.
• Aim 3: To increase both CRNAs' and SRNAs' confidence and thereby use of apneic oxygenation techniques during endotracheal intubations in the clinical setting.
◦ Outcome/Indicator 3a: Following the education session, at least 75% of CRNAs and SRNAs will self-report having the confidence to employ apneic oxygenation techniques in clinical practice. ◦ 100% of respondents either agreed or strongly agreed that they had the confidence to employ apneic oxygenation techniques in the clinical setting following the educational PowerPoint.
◦ Outcome/Indicator 3b: Following the education session, at least 75% of CRNAs and SRNAs will self-report being likely to use apneic oxygenation techniques in their future clinical practice. ◦ 20 out of 24 respondents (83.33%) either agreed or strongly agreed that they would use apneic oxygenation techniques in their current clinical practice following the PowerPoint presentation. Two respondents (8.33%) were neutral to using it in the clinical setting, and two respondents did not answer the question.

Statistical analysis using IBM Statistics SPSS Software also found that there was a statistically significant difference in mean scores between the pre-intervention test and post-intervention test and the post-test mean score increased over 35% as compared to the pre-test mean score. Therefore, one could deduce that the educational PowerPoint was effective in educating providers on the NO DESAT technique and thereby increasing its use in the clinical setting.

The fill-in the blank question (question 16, Appendix E) regarding respondent self-report of foreseen barriers to utilizing the technique in the clinical setting was also telling. Prominent among student responses was reliance on their preceptors' agreement to perform the technique in the clinical setting. One can infer that if student nurse anesthetists' preceptors are not willing to allow students to employ evidence-backed techniques in the clinical setting, the student may either never employ the technique in their practice or be forced to delay implementing the technique until they are graduated and working without a clinical preceptor. Conversely, seasoned CRNA practitioners were more likely to attribute the longevity of their practice as being a barrier to implementing the technique in their clinical practice (i.e. "old dog learning new tricks"; "traditional old school practice").

Gaps

Of the 552 eligible members of the INANA to participate in the project, the response rate of all required components of the DNP Project was exceptionally low (4.35%). Four respondents completed the pre-intervention requirements but failed to complete the post-intervention requirements and were therefore excluded from data analysis. Thus, the final respondent count was 24. While participation was strongly encouraged through an initial email and mid-way reminder email from Kim Williams, members who did not participate were not penalized nor was participation mandatory. Lack of participation in the project created a potential limitation in the project in that the results of the project may not provide a completely accurate portrayal of all members of the INANA due to the small sample size. For example, half of the respondents were SRNAs which, owing to the fact that there are only three CRNA schools in the state of Indiana, likely does not represent the proportion of SRNAs that comprise the INANA and may have therefore jeopardized the generalizability of the project findings. Additionally, half of the respondents were SRNAs and could have likely been classmates of the project manager, which could have created response bias as the participant was aware that they were completing a project authored by a University of Saint Francis Doctoral Student.

Unanticipated Consequences

Failure to complete all components of the project which therefore necessitated omission of all responses was one unanticipated consequence of the project. As stated above, four participants failed to complete all components of the project, necessitating the project manager to omit their pre-intervention responses from final data analysis. Additionally, having a low response rate to the project could also hinder one’s ability to analyze project findings. Specifically, a low sample size could hinder one’s ability to generalize one’s findings to all members of the INANA.

Expenditures

The majority of the expenditures for this DNP Project was supported in kind by the commitment of time by key stakeholders. Dr. Greg Louck and Kim Williams assisted with the planning and implementation phases of the project through donation of their time while communicating with the project manager in person and through email and phone call communications. Throughout the years of planning and during the implementation and evaluation phases of the project, Dr. Megan Winegarden met with the project manager on a continual basis to discuss the details of the project and addressed the project manager's questions and concerns throughout the timeline of the project. The only fiscal expenditure endured by the project manager was the purchasing of the statistical analysis software (SPSS) for $76.

Chapter 5: Leadership and Management

Organizational Culture

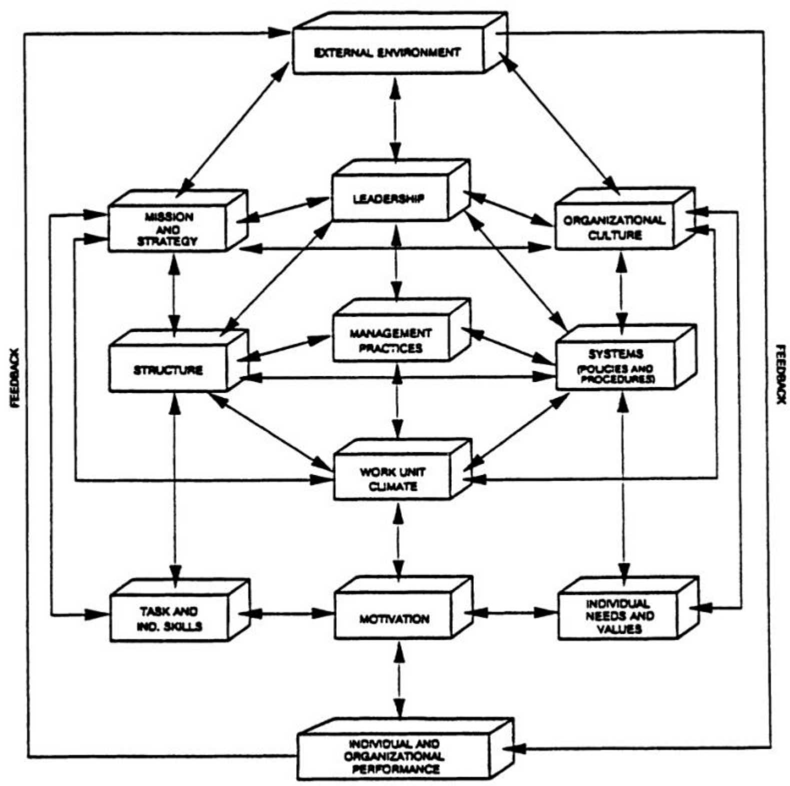
Performing an organizational assessment is a vital component to facilitating the translation of evidence to the bedside. By understanding the readiness of an organization for evidence-based practice implementation, one can predict whether the culture of the organization will serve to impede or facilitate the adoption of best practice in the clinical setting (Williams, 2016). An organizational assessment serves to evaluate the values and mission of an organization and whether or not the values and mission coincide with that of the DNP Scholarly Project and project manager (White & Zaccagnini, 2017). An organizational assessment is a critical step prior to DNP Project implementation as it acts to identify challenges to evidence translation and allows the project manager to plan for the identified challenges or assist in the decision to implement a project in a more facilitating environment (White & Zaccagnini, 2017). Though many different models can facilitate organizational assessment, this DNP Project used the Burke and Litwin Model, also known as the "Causal Model of Organizational Performance and Change," to perform an organizational assessment of the INANA.

Burke and Litwin Model

The concepts of the Causal Model of Organizational Performance and Change was first published in an article in the Journal of Management in 1992 by Burke and Litwin. Though the model was refined by a series of studies by Burke and colleagues, the original development of the model was owed to the work of Litwin and his associates (Burke & Litwin, 1992). As depicted in Figure 2, the model consists of 12 factors one should analyze when attempting to predict and explain the behaviors of an organization (Burke & Litwin, 1992). The model serves to assist in the understanding of the interactions amongst the variables and how the variables affect change within an organization (Burke & Litwin, 1992). Through the use of arrows between variables, the model illustrates which variables exert more influence over one another within the model (Burke & Litwin, 1992). The arrows that go in both directions highlight the fact that the model works on an open-system principle in which a change in one or more factors will have an impact on another variable(s) (Burke & Litwin, 1992). Thus, the model is described as being *causal* in nature (Burke & Litwin, 1992).

Figure 2

A Causal Model of Organizational Performance and Change



Graphic adapted from “A causal model of organizational performance and change,” by W. W. Burke & G. H. Litwin, 1992, *Journal of Management, 18*(3), 523-545. Copyright 1992.

The concepts of transactional and transformational change are also differentiated in the model. Transformational change within organizations occurs due to interaction with environmental forces that, in turn, affect the mission, strategy, leadership, and culture of an organization (Burke & Litwin, 1992). Burke and Litwin (1992) postulate that change within an organization stems primarily from this type of change. The top portion of Figure 2 depicts the factors involved in transformational change and include the variables external environment, mission and strategy, leadership, organizational culture, and individual and organizational performance (Burke & Litwin, 1992). The ability to be successful at transformational change was evident within the INANA. For example, the INANA was able to successfully adapt and respond to the increased need for CRNAs to be independent and have an increased scope of practice during the novel Covid-19 epidemic in 2020. The organization continued to seek more independence for CRNAs during a time when there was a shortage of providers due to an increased demand within the hospital setting.

Contained in the lower half of the model are the factors involved with transactional change and include the remaining variables not included in transformational change. The authors describe that the transactional factors of change involve a certain reciprocity among both people and groups and is short-term rather than long-term in nature (Burke & Litwin, 1992). The INANA had the ability to enact transactional change in that the organization had the motivation to adapt its mission and values to better serve its members and therefore communities in Indiana. The model contends that for change to occur, transactional and - to a higher degree - transformational change must occur within an organization.

Factors Included in the Organizational Assessment

As stated above, the Burke and Litwin model addresses what they assert are the 12 most important variables to consider when attempting to promote change within an organization. Of course, the number of variables changing at once, environmental change, and the resistance of various systems including groups and individuals can be difficult to predict and effectively impede positive change within an organization (Burke & Litwin, 1992). However, factors involved with organizational change and performance must always be assessed prior to implementation in order to truly invoke organizational change. The factors described in the Burke and Litwin Model and how they related to the implementation of this DNP Project will be discussed in the following paragraphs.

External Environment

Burke and Litwin (1992) describe that the external environment is any outside entity that influences the actions and performance of the organization. Included in this variable within the INANA was external stakeholders including INANA members (CRNAs and SRNAs), the broader community, and legislative and regulatory bodies. INANA members undoubtedly want a representative body that not only serves their members with new evidence-based research but protects patients and facilitates high-quality healthcare delivery to the community in the process. Likewise, governmental legislative and regulatory bodies seek to ensure that the care provided is cost-effective. Because of the external influence of patients, the community, INANA members, and legislative and regulatory bodies, the INANA fosters a culture that works to advance the practice of CRNAs through continual engagement with its members. The mission and vision of the INANA is to be highly engaged with its members, advocate for its members, and advance the professional growth and practice of CRNAs. As predicted by the Burke and Litwin Model, external factors were the most attributable influences for the INANA to facilitate the successful implementation of this DNP Scholarly Project.

Change Strategy

Change within an organization requires first a thorough organizational assessment along with both dedication and commitment on the part of several individuals including the project manager, an organization's administration, and the employees of an organization. Change is an integral component of an organization, and positive changes should align with the goals of an institution in order to positively benefit the organization (White et al., 2016). The elements essential for change include defined visions and goals by all involved parties (White et al., 2016). Additionally, an education plan must be in place along with evaluation methods and tools and the availability of people and groups to collaborate (White et al., 2016).

In the Burke and Litwin Model, systems are the policies and mechanisms that facilitate the work of the organization (Burke and Litwin, 1992). While systems can cover a wide array of topics, Keen (1981) discussed change in organizations in relation to information systems. Keen (1981) discussed that information is only a small piece of change and that organizations are complex and often resist change (Keen, 1981). While resistance to change is often experienced by healthcare professionals and facilities alike, the INANA readily adapts to new research and provides its members with weekly updates on changes occurring in the state. The concepts entailed in the Burke and Litwin Model depict how the factors involved with change are causal, and the model serves to highlight the importance of identifying the external influences that can work to either promote or hinder change within an organization.

Leadership Style

Leadership is distinguished from management by Burke and Litwin (1992) and involves the role of executive leadership in providing overall direction for the organization and as role models for employees. The translation of evidence to the bedside is the work of the Doctoral-prepared nurse, and a challenge for leaders it to create a culture that supports evidence translation, ignites innovation, rewards initiative, and facilitates individuals and groups that are engaged with evidence translation projects (White et al., 2016). INANA President Dr. Greg Louck was an exemplar of this style of leadership through his facilitation of this DNP Scholarly Project from the initial planning stages. Dr. Louck not only supported the project from the beginning, but also communicated with the project manager at consistent intervals, checked the progress of the planning and implementation stages, and ensured that the project manager was aware that he was available for any questions or suggestions. Dr. Louck is also the Program Director of the University of Saint Francis' Doctoral Nurse Anesthesia Program. His commitment to excellence in education is highlighted by this dual role and facilitated the implementation of this DNP Scholarly Project as it served to educate anesthesia providers on an evidence-backed technique.

Leaders motivate, inspire, support information translation, and engage with others to achieve their shared goals (White et al., 2016). As project manager for this DNP Scholarly Project, a strong leadership presence was required to plan each detail of the project, implement each step of the project at each stage, and evaluate the outcomes of the project. The project manager, Dr. Greg Louck, and DNP Project Advisor Dr. Megan Winegarden worked cohesively during the months leading up to project implementation. Without the assistance and input of each member of the project team, the project would not have been successful.

Interprofessional Collaboration

Interprofessional collaboration was a vital component to the planning, implementation, and evaluation phases of this DNP Scholarly Project. White et al. (2016) describes how daily work rounds by physicians, nurses, and other disciplines facilitate communication, enhance problem solving capabilities, and reduces errors. While rounding did not occur for this DNP Project, interdisciplinary collaboration among the SRNA (project manager), CRNA (INANA president Dr. Greg Louck), Doctoral faculty (DNP Project Advisor Dr. Megan Winegarden) and other Nurse Anesthesia Program and Doctoral faculty facilitated each stage of the project. Frequent DNP Project meetings between the project manager and key stakeholders, like rounding, served to facilitate communication and discussion of potential problems and enhanced problem-solving capabilities.

For example, project implementation was initially planned to occur at a large hospital in northwest Indiana. However, concerns arose around the Covid-19 pandemic about whether or not the project manager would be able to implement the project at a site. Together, the project manager and DNP Project Advisor Dr. Winegarden made the decision to implement in an all-online format with members of the INANA in order to prevent the possibility of a cancelled or delayed implementation date.

Due to a successful working relationship, mutual respect, flexibility, and highly effective communication, each phase of this DNP Scholarly Project was smoothly executed with very few setbacks along the way.

Conflict Management

Managing conflict is an important consideration for any DNP Scholarly Project and being able to do so in an effective manner is vital during each stage of the project. Together, the DNP project manager and key stakeholders should work together to anticipate potential conflict and be prepared should conflict arise. Not only must the DNP project manager problem-solve during times of conflict, but they must deal with conflict in an effective and respectable fashion.

However, one should be reminded that conflict is not always negative in nature but can promote positive changes through personal and professional growth and development.

While the overwhelming majority of this DNP Project went smoothly, it did encounter a few areas of conflict during the project timeline. Originally the project manager intended for the project to be implemented at a large hospital in northwest Indiana. However, during the planning phase of the project, students were unable to go to the facility due to the Covid-19 pandemic. Together, the project manager and DNP Project Advisor decided that it was best to implement the project in an all-online fashion consisting of members of the INANA. While this was not the original intention, implementing this way potentially reached more providers and hopefully benefited a larger and more diverse group of anesthesia providers within the state of Indiana.

While these setbacks were minor, they were dealt with in a professional manner. The project manager, DNP Project Advisor, and other key stakeholders remained flexible during all phases of the DNP Project. Ultimately, professionalism and effective communication proved to be invaluable factors during the planning and implementation phases of the DNP Project.

Chapter 6: Discussion

Impact of Project

The overall objective of this DNP Scholarly Project was to take previous knowledge generated by researchers and translate that knowledge into the clinical setting. Specifically, to assist in the awareness and utilization of the NO DESAT technique as an adjunct to preoxygenation and positioning during the induction of anesthesia in the obese patient population. As many CRNAs in Indiana work independently and are oftentimes the sole provider at a facility at any given time, utilizing evidence-based techniques such as NO DESAT can serve to assist in prolonging the time to desaturation and increase the patient's lowest SpO_2 during anesthetic induction. Guiding anesthetic practice with the assistance of available evidence is vital to enhance the safety of anesthesia in particularly vulnerable patients, such as the obese patient population. Implementing the project with members of the INANA coincided with the project team's aim of reaching as many providers as possible with this quality improvement project and hopefully increasing patient safety as a result.

While the participation rate among members of the INANA was lower than expected, the responses to the project from members of the INANA was highly positive. Table 6.1 shows responses from members of the INANA to the post-intervention survey section where participants were able to provide additional comments if desired after completing all parts of the project.

Table 6.1	
Responses to fill-in-the-blank question "Additional Comments" in the post-intervention	*"Never heard of this before…."* *"Love this technique. I even use during deep IV sedation. Great and informative powerpoint. Best to you on your journey to become a CRNA."* *"Nice job and good luck with your project!"*

survey (Appendix E).	*"I would like to try in practice to see it in action. Presentation helpful as I was not familiar with this."* *"Phenomenal presentation and an extremely underutilized technique in practice that deserves more attention."* *"Very informative"* *"Nice job! I look forward to using this technique"* *"Great information"*

Because this project was merely a self-report by participants of whether or not they would utilize the technique following the educational PowerPoint, the Project Manager can only use the data collected to deduce that the overwhelming majority (83.33%) of participants who completed the project would utilize NO DESAT in their future practice. The project was successful in part because it not only increased CRNA/SRNA knowledge of NO DESAT but also increased CRNA/SRNA confidence in employing the technique in the clinical setting.

Decisions and Recommendations

As stated in the literature review of this DNP manuscript, 27% of all adverse respiratory events in the ASA database were attributed to difficult airway management, with 67% occurring on induction (Pratt & Miller, 2016). Undoubtedly, many of these patients were likely obese and at high risk for rapid desaturation during apnea as a result. Utilizing an evidence-based technique such as NO DESAT can help curb the rapid desaturation often seen in the obese patient population and enhance patient safety during the induction of anesthesia. As the incidence of obesity continues to incline in the United States, more awareness of the NO DESAT technique should be encouraged for anesthesia providers to employ to keep a high proportion of patients safe. Ultimately, facilities that care for obese patients should keep up to date with best practices when caring for this patient population and employ best-practice recommendations in the clinical setting to enhance patient safety and outcomes.

Limitations of the Project

While the project was overall a success in that it exceeded all of the aims and objectives made during the planning stage, there were limitations of the project. One significant limitation was the low response rate from members of the INANA. Only 24 out of 552 members (4.35%) completed all parts of the project and were included in the final data analysis. Because of the low response rate, the results from data analysis may not be entirely representative of all members of the INANA. A larger response rate would have been more representative of all members of the INANA and improve the generalizability of the findings.

Additionally, half of the responses were student nurse anesthetists who could have gone to the same Nurse Anesthesia Program as the project manager, which could have resulted in response bias as the participant may have known the identity of the project manager and altered responses as a result.

Another limitation to the project was that concluding whether or not participants would actually use the technique in practice was through self-report on a Likert scale question in the post-intervention survey (question 12, Appendix E). While the majority of respondents (83.33%) self-reported that they would use the technique in their clinical practice, without being able to observe respondents actually perform the technique was a limitation. Participants could have reported that they would use it in their clinical practice following the PowerPoint presentation but ultimately fail to do so, which could have resulted in overestimation of the overall impact of the project on participants.

Application to Other Settings

Implementation of a project similar to this DNP Project at a semi-annual state Nurse Anesthesia conference (such as the INANA) would serve to enhance CRNA/SRNA awareness and ultimate usage of the NO DESAT technique in clinical practice. While the response rate for this all-online DNP Project was exceptionally low, an in-person presentation with the ability to answer questions and welcome feedback from members would likely enhance member engagement and interest in evidence-backed techniques and methods to improve patient safety during the induction of anesthesia. Unfortunately, due to the novel Covid-19 pandemic, in-person conferences were largely held via an online format or cancelled altogether, necessitating the project to be an all-online format.

Strategies for Maintaining and Sustaining

While initial strategies and methods to enhance the safety of anesthetic induction in the obese patient population is vital, the sustained adherence to evidence-backed techniques is necessary to truly impact patient care and enhance patient safety. Ultimately, it is the decision of anesthesia providers to implement techniques in their clinical practice that are known to improve patient outcomes, such as the NO DESAT technique. Additionally, CRNAs and SRNAs alike must cultivate an environment that facilitates learning and utilizes evidence-based techniques in their quest to improve patient care. Maintaining and sustaining an environment that focuses on patient safety - particularly the safety of the obese patient population - requires CRNAs and SRNAs that are willing to make NO DESAT a standard of care during the induction of anesthesia.

Lessons Learned

While reflecting on the planning, implementation, and evaluation stages of this DNP Scholarly Project, some of the strengths and areas of improvement regarding the project in its entirety come to mind. Hopefully, some of the listed points in the following paragraph will assist a doctoral student in his or her project by learning from someone who has already implemented and evaluated a project. For one, the project manager would reconsider implementing entirely online. A state anesthesia conference would likely consist of engaged members who are excited to learn about evidence-based practices and techniques. Additionally, having the ability to answer questions and address audience concerns in-person would not only enhance engagement but also likely increase the probability that practitioners would utilize the technique in their practice. Moreover, the project manager would be able to demonstrate the technique in front of the audience and receive instant feedback from members. An unanticipated outcome of the project was that an all-online project failed to reach more practitioners compared to an in-person seminar, likely due to email overload.

Ultimately, the project achieved all of its aims set forth during the planning stages of the project. Not only did CRNA and SRNA knowledge of NO DESAT increase as a result of the PowerPoint presentation, but participants reported confidence in addressing barriers to the technique as well as reported a high likelihood of employing the technique in their clinical practice. No project is perfect, but the lessons learned from the years of planning and weeks of implementing and evaluating will carry through the project manager’s lifetime of anesthesia practice.

Chapter 7: Conclusion

Potential Project Impact on Health Outcomes Beyond Implementation Site

Anesthesia is often likened to aviation, with the initial takeoff, subsequent cruising and landing being analogous to induction, maintenance, and emergence. The most critical portions of each specialty occur in the beginning and the end. Therefore, it is critical that certain measures are in place to enhance patient safety, particularly in the patients that are most vulnerable. As stated in the literature review, 27% of all adverse respiratory events in the ASA database were attributed to difficult airway management, with 67% of these events occurring on induction (Pratt & Miller, 2016). The adoption of techniques and methods to enhance the safety of anesthetic induction in the obese patient population is paramount as well as the sustained adherence to evidence-backed techniques. While the information in this DNP Project was intended for members of the Indiana Association of Nurse Anesthetists, the findings of the project could be shared with other state associations. Additionally, the NO DESAT technique could be integrated in the academic requirements of CRNA programs across the country and could be taught in the classroom with a simulation to follow. As seen in the analysis chapter 4 of this DNP Project manuscript, many providers – both seasoned and novices – had never heard of this technique before participating in the project. Reaching more CRNAs and SRNAs about this technique and the evidence supporting it could help curb the rapid desaturation often seen with obese patients and enhance patient safety as a result.

Health Policy Implications of Project

Evidence-based practice in nursing serves to bridge the gap between knowledge found in research and the practices that occur in the clinical setting. The theory-practice gap is present in the realm of anesthesia as well. As discussed in the literature review, several research articles support the use of apneic oxygenation techniques during anesthetic induction. An article by King and Jagannathan (2018) suggested that apneic oxygenation techniques become the standard of care during anesthetic induction of obese patients. The project manager believes that the evidence supports the above claim by King and Jagannathan. Incorporating apneic oxygenation techniques in the clinical practice guidelines for anesthesia providers could serve to prolong the time to desaturation and increase the minimal SpO_2 experienced by obese patients during anesthetic induction. The potential impact of adopting this technique into a clinical practice guideline would serve to align health policy and evidence-based practice in anesthesia. Ultimately, adherence to any evidence-backed technique relies on anesthesia providers that are committed to putting into clinical practice that which is found in research evidence.

Proposed Future Direction for Practice

As discussed previously, a high percentage of CRNAs work outside of academic institutions and oftentimes provide anesthesia for rural and other underserved communities. An advantage of academic medical institutions is that new evidence and evidence-based techniques are integrated into practice in a more seamless fashion. Therefore, both CRNAs in the field and SRNAs must engage in learning, utilizing, and adhering to evidence-based techniques that can streamline patient care and enhance patient safety. Additionally, both CRNAs and SRNAs must cultivate an environment that focuses on keeping up to date with new evidence to support the continual enhancement of patient safety. Adoption of best-practice recommendations regarding apneic oxygenation techniques and incorporating the practice into the anesthesia standard of care during anesthetic induction is vital to enhance safety in the obese patient population.

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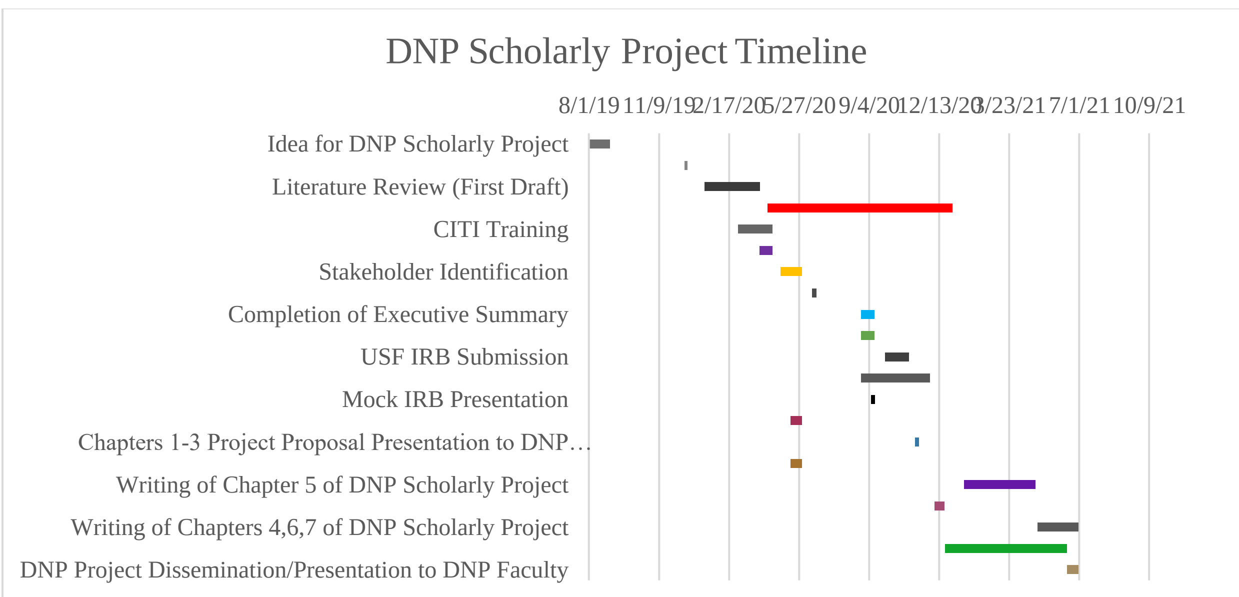
Appendix A

DNP Project Timeline

Task Name	Start Date	End Date	Duration
Idea for DNP Scholarly Project	8/1/19	8/31/19	30
DNP Scholarly Project Approval	12/16/19	12/20/19	4
Literature Review (First Draft)	1/13/20	4/1/20	79
Literature Review (Final Draft)	4/12/20	1/1/21	264
CITI Training	3/1/20	4/19/20	49
Development of Informed Consent	4/1/20	4/19/20	18
Stakeholder Identification	5/1/20	5/31/20	30
DNP Project Cost Assessment	6/15/20	6/21/20	6
Completion of Executive Summary	8/24/20	9/12/20	19
Facility IRB Application	8/24/20	9/12/20	19
USF IRB Submission	9/27/20	10/31/20	34
Writing of Chapters 1,2,3 of DNP Scholarly Project	8/24/20	11/30/20	98
Mock IRB Presentation	9/7/20	9/12/20	5
SWOT Analysis	5/15/20	5/31/20	16
Chapters 1-3 Project Proposal Presentation to DNP Faculty	11/9/20	11/14/20	5
Organizational Assessment	5/15/20	5/31/20	16
Writing of Chapter 5 of DNP Scholarly Project	1/18/21	4/30/21	102
DNP Project Implementation	12/7/20	12/21/20	14
Writing of Chapters 4,6,7 of DNP Scholarly Project	5/3/21	6/30/21	58
DNP Project Results, Analysis, and Conclusion	12/22/20	6/14/21	174
DNP Project Dissemination/Presentation to DNP Faculty	6/14/21	6/30/21	16



Appendix B

Section II.F.

INFORMED CONSENT

Title: NO DESAT: The Use of Nasal Oxygen During Preoxygenation and Tracheal

Intubation of Obese Patients Undergoing General Anesthesia

My name is Sable Yrjanson and I am a doctoral student in the University of Saint Francis' Nurse Anesthesia Program. I, along with the assistance of my DNP Project advisor Dr. Megan Winegarden, am conducting a quality improvement project on anesthesia providers utilizing apneic oxygenation techniques, specifically NO DESAT ("Nasal Oxygen During Effort Securing a Tube"), on obese adult surgical patients undergoing general anesthesia with an endotracheal tube.

Purpose of the Project: The purpose of this project is to increase the safety of obese surgical patients during anesthetic induction and to increase CRNA/SRNA knowledge of and use of NO DESAT in the clinical setting. By checking 'yes' below, you are giving your consent for the data related to the project to be collected, analyzed, and reported.

Potential Risks and Benefits: There are no anticipated risks or discomforts to subjects for participating in this DNP Project, and subjects are at no risk for harm or damages as a result of participation. Participation in this project is strictly voluntary and participants will not be compensated or charged a fee for participation. Answers to questionnaires and surveys via Microsoft Forms will be deidentified to ensure participant privacy and confidentiality. Responses to the demographic questionnaire, pre-test, post-test, and post-educational survey will remain anonymous.

Voluntary Participation/Explanation of the Safeguards for Participation and the Freedom to Withdraw: Participation in this project is completely voluntary. CRNAs/SRNAs participating in this project will not be directly identifiable, and no information published will be directly linked to any one specific provider. The data collected in this project is completely confidential and responses will remain anonymous. Confidential data collection will be ensured as the collection method will involve encrypted data that will only be directly viewed by the project manager. Additionally, the data collected will be safeguarded on one private computer. The aggregate data collected from this project will be shared and disseminated with both DNP faculty and University of Saint Francis DNP students upon the completion of the project. The results from this project will be reported in aggregate (group) only and no disclosure of participant identity nor any identifying information will be discussed. As a voluntary participant, you have the right to withdraw from this DNP Scholarly Project at any time and will not experience any punitive action for your choice to withdraw. Please note that in order to participate in this project, informed consent must be obtained.

Contact Information: Following the completion of this project, it would be an honor to disseminate the results to you whether or not you participated in the project. In the meantime, if you have any questions regarding this project please feel free to contact us via mail, phone, or email at the contact information provided below:

Sable Yrjanson c/o USF Nurse Anesthesia Program
2701 Spring Street
Fort Wayne, Indiana 46808
Phone: (765) 432-4395
Email: WallSA1@cougars.sf.edu

Dr. Megan Winegarden
2701 Spring Street
Fort Wayne, Indiana 46808
Phone: (260) 399-7700 ext. 8513
Email: mwinegarden@sf.edu

If you have any complaints about your treatment as a participant in this study, please call or write to the following:

IRB Chairperson
University of Saint Francis
2701 Spring Street
Fort Wayne, Indiana 46808
(260) 399-7700
Administration email: IRB@sf.edu

This research project has been approved by the University of Saint Francis' Institutional Review Board for the Protection of Human Subjects for a one-year period.

By checking 'yes' below, you confirm that you have read and agree to the terms stated above.

Appendix C

General and Demographic Questionnaire

Instructions: Please read each question and check the answer that best represents your response.

1. How many years have you practiced anesthesia?

   A. Less than one year
   B. 1-5 years
   C. 6-10 years
   D. 11-20 years
   E. 21 years or more

2. Please indicate if you are currently a CRNA or SRNA:

   A. CRNA
   B. SRNA

3. What is your current employment status?

   A. Full-time
   B. Part-time
   C. Per diem
   D. Student

4. What kind of practice do you currently work?

   A. ACT Model
   B. Independent Practice
   C. Locum Tenens
   D. Student
   E. Other

5. Are you currently employed/attending clinical at a facility where you regularly perform endotracheal intubations?
   A. Yes
   B. No

6. How many times have you utilized apneic oxygenation techniques during the induction of anesthesia?

A. 0 times
B. 1-5 times
C. 6-10 times
D. 11 times or more

Thank you for your time in completing this survey.

Appendix D

Pre-test

Instructions: Please read each question and check the answer that best represents your response.

1. When utilizing apneic oxygenation techniques, nasal oxygen should be discontinued:
   a. When the patient begins to spontaneously breathe.
   b. Prior to performing laryngoscopy.
   c. After the endotracheal tube is safely secured.
   d. It should not be discontinued; run a low rate of oxygen (2L/min) until the end of the procedure.

2. True or false: The acronym NO DESAT stands for Nasal Oxygen During Efforts Securing a Tube.
   a. True
   b. False

3. The safe limit of apneic oxygenation is estimated to be how long?
   a. Less than 5 minutes
   b. 15 minutes
   c. 30 minutes
   d. Up to one hour

4. The goal of apneic oxygenation is to:
   a. Slow the rate of rise of carbon dioxide in the lungs while the patient is apneic.
   b. Prevent atelectasis.
   c. Prolong the safe apnea time.
   d. Prevent alveolar collapse.

5. When used in conjunction with apneic oxygenation techniques, which of the following can significantly prolong the safe apnea time of obese patients undergoing general anesthesia with an endotracheal tube?
   a. 25-degree head-up position
   b. PEEP
   c. Patent airway
   d. All of the above

6. When utilizing apneic oxygenation techniques with a nasal cannula, how many liters per minute should the nasal cannula be set to during *preoxygenation*?
   a. 2 L/minute
   b. 5 L/minute
   c. 10 L/minute
   d. 15 L/minute

7. Which of the following is true about apneic oxygenation:
   a. The duration of time until a patient desaturates is prolonged
   b. The incidence of desaturation is decreased.
   c. There is an increased first-pass intubation success when apneic oxygenation is used.
   d. All of the above are true.

8. Apneic oxygenation techniques have been shown to be beneficial in all of the following patient populations *except* for:
   a. Pediatric patients
   b. Obstetric patients
   c. Obese patients
   d. Critically ill patients

9. You are performing anesthesia on a 65-year old male with a BMI of 52. He has severe sleep apnea and the case requires a general anesthetic with an endotracheal tube. As the anesthesia provider for this case, you decide he is a great candidate for apneic oxygenation techniques. According to the literature, when should you apply the nasal cannula and turn on the flow of oxygen?
   a. During preoxygenation.
   b. After the patient becomes apneic.
   c. Prior to stage 2 of anesthesia to avoid injury.
   d. Immediately prior to attempting laryngoscopy.

10. Potential complications associated with the use of apneic oxygenation include all of the following *except:*
    a. Lowering of arterial pH.
    b. A rise in alveolar carbon dioxide level.
    c. Drying of the nasal mucosa.
    d. Elevation of arterial pH.

Thank you for your time in completing this survey.

Appendix E

Post-test and Post-educational Survey

Instructions: Please read each question and check the answer or fill in the blank that best represents your response.

2. When utilizing apneic oxygenation techniques, nasal oxygen should be discontinued:
   a. When the patient begins to spontaneously breathe.
   b. Prior to performing laryngoscopy.
   c. After the endotracheal tube is safely secured.
   d. It should not be discontinued; run a low rate of oxygen (2L/min) until the end of the procedure.

3. True or false: The acronym NO DESAT stands for Nasal Oxygen During Efforts Securing a Tube.
   a. True
   b. False

4. The safe limit of apneic oxygenation is estimated to be how long?
   a. Less than 5 minutes
   b. 15 minutes
   c. 30 minutes
   d. Up to one hour

5. The goal of apneic oxygenation is to:
   a. Slow the rate of rise of carbon dioxide in the lungs while the patient is apneic.
   b. Prevent atelectasis.
   c. Prolong the safe apnea time.
   d. Prevent alveolar collapse.

6. When used in conjunction with apneic oxygenation techniques, which of the following can significantly prolong the safe apnea time of obese patients undergoing general anesthesia with an endotracheal tube?
   a. 25-degree head-up position
   b. PEEP
   c. Patent airway
   d. All of the above

7. When utilizing apneic oxygenation techniques with a nasal cannula, how many liters per minute should the nasal cannula be set to during *preoxygenation*?
    a. 2 L/minute
    b. 5 L/minute
    c. 10 L/minute
    d. 15 L/minute

8. Which of the following is true about apneic oxygenation:
    a. The duration of time until a patient desaturates is prolonged
    b. The incidence of desaturation is decreased.
    c. There is an increased first-pass intubation success when apneic oxygenation is used.
    d. All of the above are true.

9. Apneic oxygenation techniques have been shown to be beneficial in all of the following patient populations *except* for:
    a. Pediatric patients
    b. Obstetric patients
    c. Obese patients
    d. Critically ill patients

10. You are performing anesthesia on a 65-year old male with a BMI of 52. He has severe sleep apnea and the case requires a general anesthetic with an endotracheal tube. As the anesthesia provider for this case, you decide he is a great candidate for apneic oxygenation techniques. According to the literature, when should you apply the nasal cannula and turn on the flow of oxygen?
    a. During preoxygenation.
    b. After the patient becomes apneic.
    c. Prior to stage 2 of anesthesia to avoid injury.
    d. Immediately prior to attempting laryngoscopy.

11. Potential complications associated with the use of apneic oxygenation include all of the following *except:*
    a. Lowering of arterial pH.
    b. A rise in alveolar carbon dioxide level.
    c. Drying of the nasal mucosa.
    d. Elevation of arterial pH.

General Questions:

12. Following the PowerPoint Presentation regarding apneic oxygenation and NO DESAT, I have confidence employing the technique in clinical practice:
    a. Strongly agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly disagree

13. Following the PowerPoint Presentation, I will use AO techniques in patients at high risk for rapid desaturation during apnea.
    f. Strongly agree
    g. Agree
    h. Neutral
    i. Disagree
    j. Strongly disagree

14. The PowerPoint Presentation enhanced my knowledge about apneic oxygenation and NO DESAT.
    a. Strongly agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly disagree

15. Please indicate what you believe is the most significant barrier to the employment of AO techniques in clinical practice.
    a. Cost
    b. Lack of time
    c. Forgetting to do it in practice
    d. Lack of resources
    e. I do not believe it is a necessary technique to utilize in my practice
    f. There are no barriers

16. Do you feel confident addressing the identified barrier in the question above in your clinical setting?
    a. Yes
    b. No

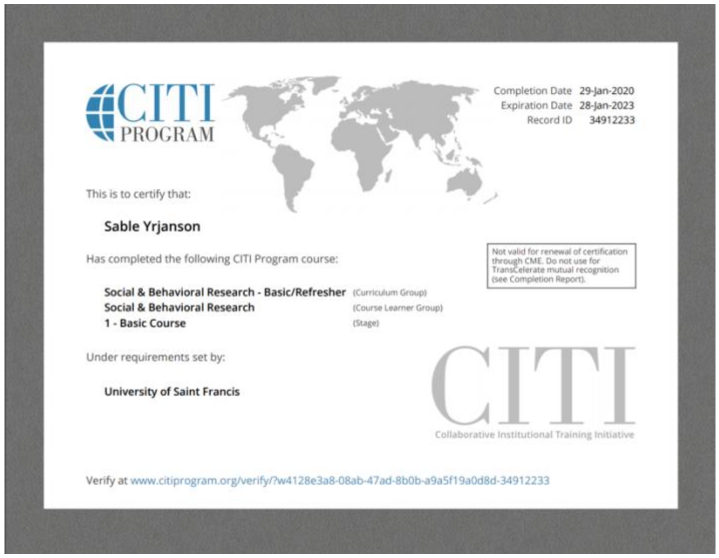
17. Please list any other barriers you can identify to utilizing AO techniques in the clinical setting.

Additional comments:

Thank you for your time in completing this survey.

Appendix F-J

CITI Training Certificates



CITI PROGRAM

Completion Date 29-Jan-2020
Expiration Date 28-Jan-2023
Record ID 34912233

This is to certify that:

Sable Yrjanson

Has completed the following CITI Program course:

Not valid for renewal of certification through CME. Do not use for TransCelerate mutual recognition (see Completion Report).

Social & Behavioral Research - Basic/Refresher (Curriculum Group)
Social & Behavioral Research (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

University of Saint Francis

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w4128e3a8-08ab-47ad-8b0b-a9a5f19a0d8d-34912233

CITI PROGRAM

Completion Date 16-Mar-2020
Expiration Date N/A
Record ID 34912234

This is to certify that:

Sable Yrjanson

Has completed the following CITI Program course:

Not valid for renewal of certification through CME. Do not use for TransCelerate mutual recognition (see Completion Report).

Information Privacy Security (IPS) (Curriculum Group)
Researchers (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

University of Saint Francis

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w24cb2d05-c0ad-49c8-ae2e-ad03f0b62d6c-34912234

CITI PROGRAM

Completion Date 19-Mar-2020
Expiration Date 19-Mar-2023
Record ID 34912235

This is to certify that:

Sable Yrjanson

Has completed the following CITI Program course:

Not valid for renewal of certification through CME. Do not use for TransCelerate mutual recognition (see Completion Report).

Social and Behavioral Responsible Conduct of Research (Curriculum Group)
Social and Behavioral Responsible Conduct of Research (Course Learner Group)
1 - RCR (Stage)

Under requirements set by:

University of Saint Francis

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w921b30f5-67d6-43fa-96de-ea07895bccb7-34912235

CITI PROGRAM

Completion Date 06-Feb-2020
Expiration Date 05-Feb-2023
Record ID 34912236

This is to certify that:

Sable Yrjanson

Has completed the following CITI Program course:

Not valid for renewal of certification through CME. Do not use for TransCelerate mutual recognition (see Completion Report).

GCP – Social and Behavioral Research Best Practices for Clinical Research (Curriculum Group)
GCP – Social and Behavioral Research Best Practices for Clinical Research (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

University of Saint Francis

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w9454f65e-f8c0-4cf2-a577-d3951c6d4133-34912236

CITI PROGRAM

Completion Date 16-Mar-2020
Expiration Date 16-Mar-2023
Record ID 34912237

This is to certify that:

Sable Yrjanson

Has completed the following CITI Program course:

Not valid for renewal of certification through CME. Do not use for TransCelerate mutual recognition (see Completion Report).

Public Health Research (Curriculum Group)
Public Health Research (Course Learner Group)
1 - Basic (Stage)

Under requirements set by:

University of Saint Francis

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w51d29421-eb2e-4f52-9341-c35a00f724de-34912237

Appendix K

Letter of Support

August 26, 2020

To the University of Saint Francis Institutional Review Board:

This letter is being written in support of University of Saint Francis NAP/DNP Sable Yrjanson's Doctor of Nursing Practice Project Scholarly Project entitled NO DESAT: The Use of Nasal Oxygen During Preoxygenation and Tracheal Intubation of Obese Patients Undergoing General Anesthesia. The Indiana Association of Nurse Anesthetists (INANA) understands that the aims of the DNP Scholarly Project are to educate practicing CRNAs and SRNAs about the risks associated with endotracheal intubation of obese patients and techniques backed by evidence to enhance patient safety when undergoing endotracheal intubation.

The INANA is supportive of the aims of the project. The INANA supports the distribution of a survey, followed by an educational PowerPoint and follow-up survey to members of the INANA. As President of the INANA, I grant permission of the aforementioned DNP Project to be conducted using the members of the INANA organization as project participants, and IRB submission is not required to the INANA for the project to be conducted.

The INANA and its leaders are committed to the successful implementation of Sable Yrjanson's DNP Scholarly Project entitled NO DESAT: The Use of Nasal Oxygen During Preoxygenation and Tracheal Intubation of Obese Patients Undergoing General Anesthesia and are eager to assist in any way to ensure its successful completion.

Sincerely,

Dr. Greg Louck

INANA President
Email: glouck@sf.edu
Phone: (260) 399-7700 x8574

Appendix L

USF IRB Letter of Approval

University of Saint Francis
Institutional Review Board
Human Subjects Review Committee/ACUC/IBC
Institutional Review Board Approval Form

Protocol Number: 16004400251-HSRC

Review by (underline one): HSRC ACUC IBC

Date Reviewed: 10/12/2020
Principal Investigator: Sable Yrjanson
Faculty Advisor: Dr. Megan Winegarden
Protocol Title: No DESAT The use of nasal oxygen during preoxygenation and tracheal intubation of obese patients
Study Site(s): NA

Type of Proposal:
Original research
Replication or extension of previous research
Quality Improvement/Evidence-Based Practice Project

Items submitted for review:
☒CITI Certificate
☒Initial protocol
☒Abstract
☒Informed Consent Form (if applicable)
☒Approval letter from outside institution - INANA
☒Other – explain: pre/post-test surveys;

Type of Review:
☒Full Review
☐Expedited Review
☐Exempt Review

Approval:
☒Approval granted on 10/12/2020
☐Approval granted on ____________ for a period of one year.
☐Conditional approval* granted on _____________ for a period of one year.
☐Not approved*
☐IRB approval is not required:
☐Other

*Comments: ____

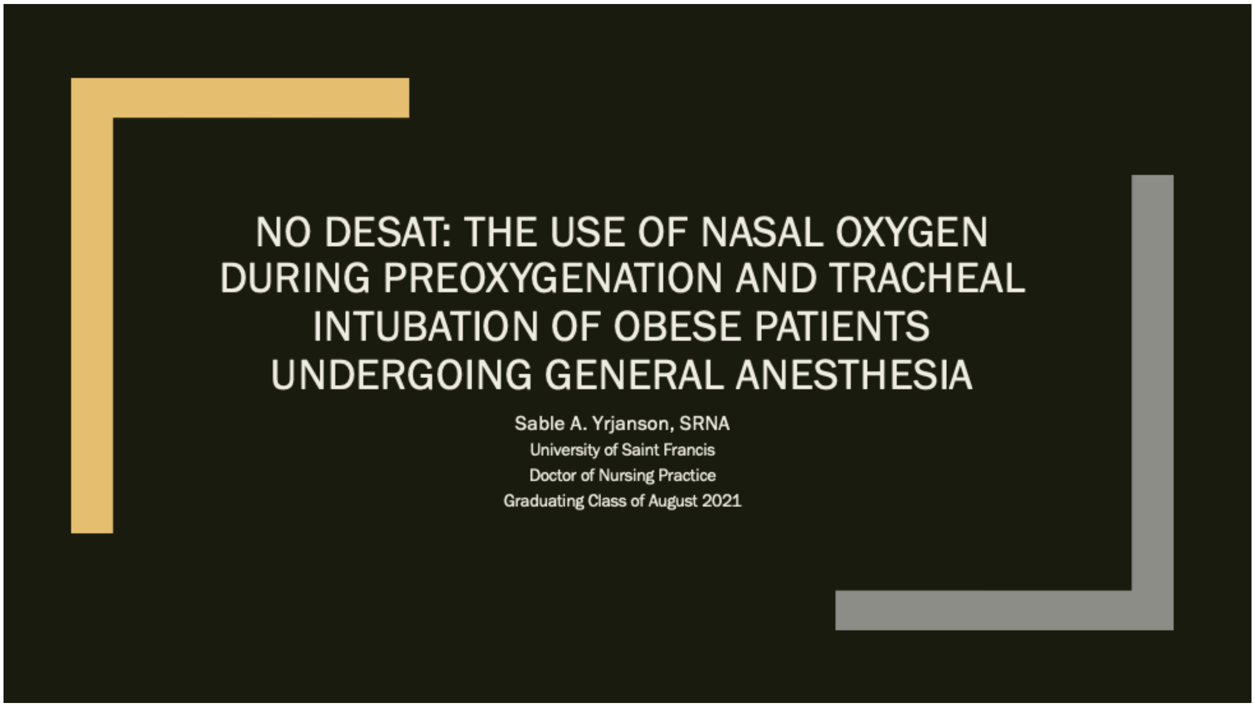
The committee performing this review is duly constituted and operates in accordance and compliance with local and federal regulations and guidelines.

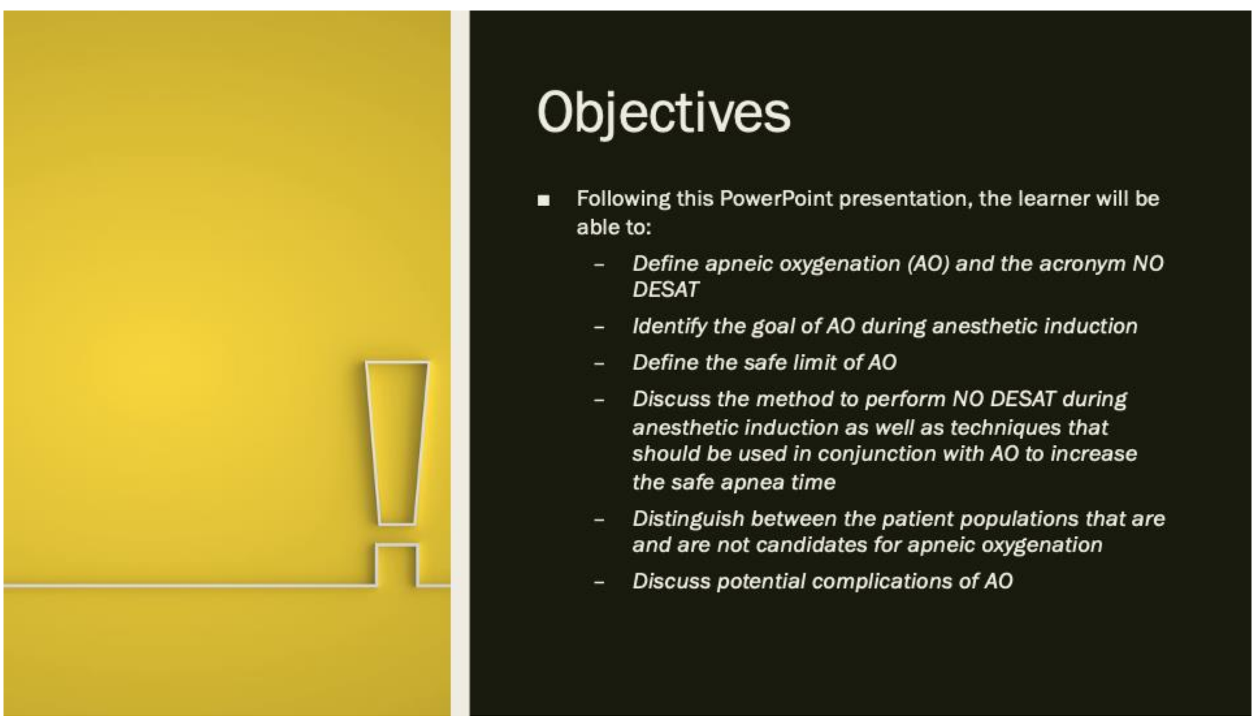
Stephanie Oetting	*Stephanie Oetting*	10/12/2020
Printed Name (Chair or designee)	Signature	Date

IRB Committee Approval Form sjo 10/12/2020

Appendix M

INANA PowerPoint





Background of the Problem

- Between 2017-2018, the prevalence of obesity (defined as a body mass index of 30 or greater) among US adults was 42.4% (Centers for Disease Control and Prevention, 2018).
- In the supine position, functional residual capacity (FRC) in obese adult males is approximately **1.9 liters** compared to **2.6 liters** in normal weight individuals (Jense et al., 1991).
  - As a result, obese patients have a reduced supply of oxygen during periods of apnea.
- Following the induction of anesthesia, morbidly obese patients experience a **50%** decrease in their FRC as compared to pre-anesthetic levels, whereas non-obese patients experience a **20% decrease** (Murphy & Wong, 2013).

Adverse Respiratory Events and the Obese Patient Population

- Obese adults experience increased fatty tissue within pharyngeal structures, increased oxygen consumption, widened alveolar-arterial gradient, high respiratory rates, reduced lung volumes, higher minute ventilation, reduced total respiratory system compliance, and increased airway resistance. Together, these increase the likelihood of a difficult airway and therefore the risk of rapid oxygen desaturation perioperatively (Murphy & Wong, 2013).
- The incidence of difficult intubation is **15.5%** in obese patients compared to **2.2%** in non-obese patients (Juvin et al., 2003).
- The United Kingdom Fourth National Audit Project reported a ***fourfold*** increase in the risk of serious complications associated with airway management of morbidly obese patients when compared with non-obese patients (Murphy & Wong, 2013).

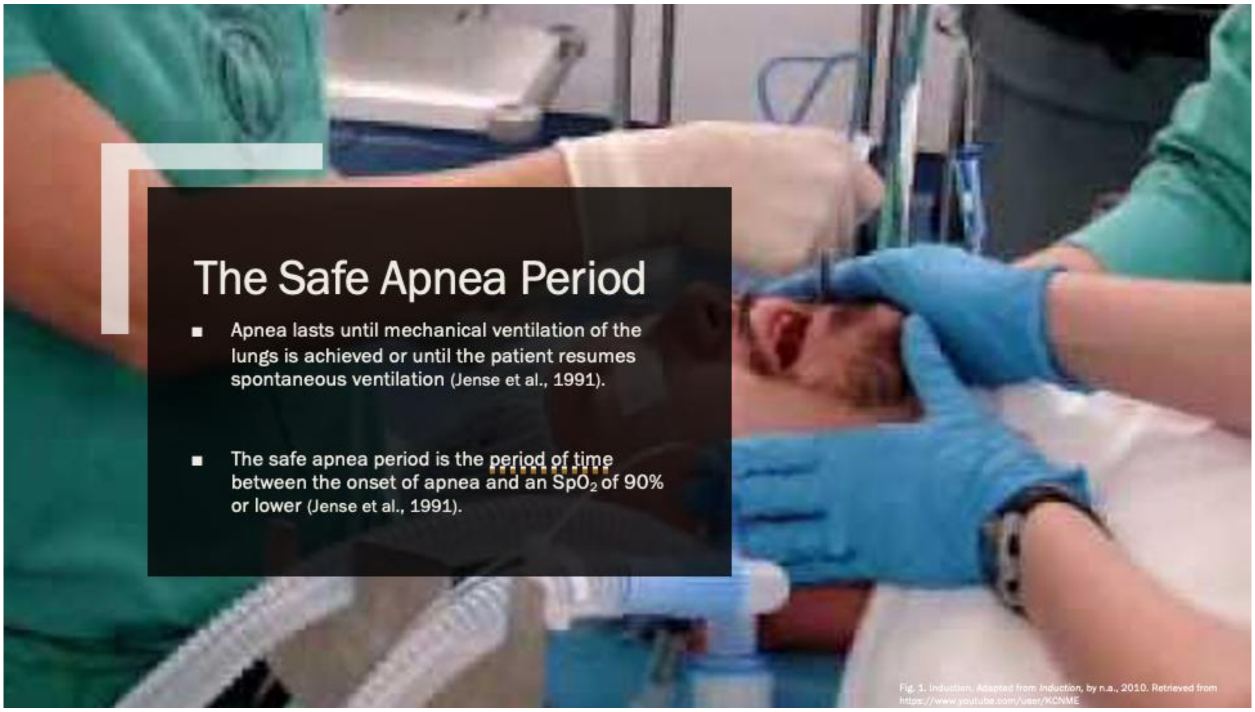


Fig. 1. Induction. Adapted from Induction, by n.a., 2010. Retrieved from https://www.youtube.com/user/KCNME

Oxyhemoglobin Dissociation Curve

- Oxygen saturation varies with the PaO_2 in a nonlinear fashion (Madan, 2017).
- Takeaway: when the patient's pulse oximetry falls below 90%, the PaO_2 rapidly declines and oxygen delivery to the tissues is decreased (Madan, 2017; Nimmagadda et al., 2017; Pavlov et al., 2017). The upper part of the curve serves as a buffer in that the PaO_2 can drop to around 60 mmHg while hemoglobin still remains highly saturated (90%) with oxygen.

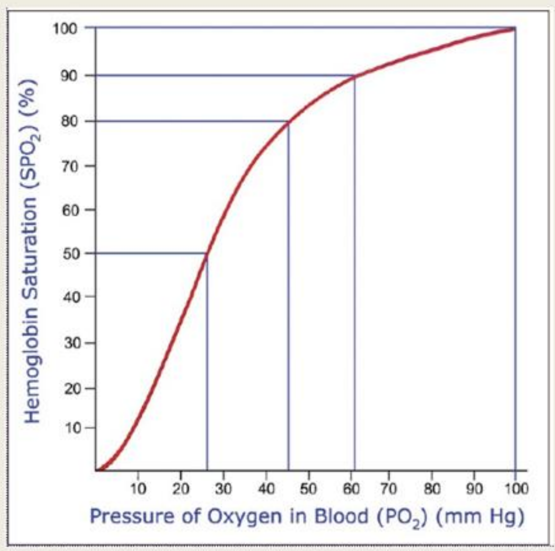


Figure 2. Oxyhemoglobin dissociation curve. Adapted from "Correlation between the levels of SpO_2 and PaO_2," by A. Madan, 2017, *Lung India, 34*(3), 307-308. Copyright 2017 by the Indian Chest Society.

Desaturation- Why it Matters

- Desaturation below 90% puts patients on the steep portion of the oxyhemoglobin dissociation curve and is the point at which critical levels of oxygen saturation (<70%) can occur within moments (Weingart & Levitan, 2012).
- Desaturation to below 70% puts patients at risk for dysrhythmias, hemodynamic decompensation, hypoxic brain injury, and death (Weingart & Levitan, 2012).

Adverse Respiratory Events

- From 1990-2007, adverse respiratory events accounted for **17%** of the most damaging events in the closed-claim database of the American Society of Anesthesiologists (ASA) and **31.8%** of the closed-claims database of the American Association of Nurse Anesthetists (AANA) (Pratt & Miller, 2016).
- **27%** of all adverse respiratory events in the ASA database were attributed to difficult airway management.
  - **67%** of these occurred on induction (Pratt & Miller, 2016).

What is Apneic Oxygenation (AO)?

- During apnea, oxygen diffuses across the alveolar capillary membrane and into the bloodstream at a rate of 250 mL per minute while carbon dioxide diffuses into the alveoli at a rate of 8-20 mL per minute until oxygen stores are depleted (Brown, 2015).
- This results in an alveolar net pressure that is sub-atmospheric.
- When high partial pressures of oxygen are administered in the pharynx by AO techniques, the pressure gradient causes the gases in the pharynx to diffuse passively into the alveoli, further oxygenating them (Brown, 2015; Weingart & Levitan, 2012).
- AO permits the maintenance of oxygenation even when spontaneous or manually administered ventilations are not present (Weingart & Levitan, 2012).

Support for AO

- *In a meta-analysis involving multiple studies and over 1,000 patients, AO was associated with decreased hypoxemia, increased first-pass intubation success, and increased lowest peri-intubation SpO_2 (Oliveira et al., 2017).*
- *Ultimately, the goal of AO is to prolong the safe apnea time.*

What is NO DESAT?

- ***"Nasal Oxygen During Efforts Securing a Tube"***
  - First described by Drs. Scott Weingart and Richard Levitan as an apneic oxygenation technique for patients requiring emergency airway management (Weingart & Levitan, 2012).
- Particularly useful in patients at high risk for rapid desaturation following anesthetic induction, including pediatric, obstetric, and obese patients.
  - ***AO has NOT been shown to be of benefit during intubation of critically ill patients (Semler et al., 2016).***
- With optimal conditions, PaO_2 can be maintained at around 100 mmHg for up to 100 minutes even without the administration of breaths or the patient taking any spontaneous breaths (Weingart & Levitan, 2012).

Fig. 3. NODESAT. Adapted from *NODESAT*, by Weingart & Levitan, 2012. Retrieved from https://epmonthly.com/article/no-desat/

The NO DESAT Technique

- The use of a nasal cannula is the technique of choice when providing apneic oxygenation.
  - The nasal cannula should remain on the patient during both preoxygenation and induction of general anesthesia (Weingart & Levitan, 2012).
- ***Prior to preoxygenation***, provide oxygen via a nasal cannula at ***5 liters per minute*** (Mushambi et al., 2015).
  - Apply a face mask and initiate standard preoxygenation.
  - The flow can be turned up to 15 liters per minute when the patient becomes apneic (Frerk et al., 2015).
- **The flow of oxygen should be turned off and the nasal cannula removed after the endotracheal tube is safely secured.**

Adjuncts to AO and NO DESAT in the Obese Population

- Factors that should be used in conjunction with NODESAT in the obese patient population include:
  - ***Remember the 4 Ps:***
    - 25-degree head up **position**
      - *In the flat supine position, cephalad displacement of the diaphragm further reduces FRC.*
    - Adequate **preoxygenation:** this should occur with 100% inspired oxygen
      - *Recommended to occur for either a minimum of three minutes or eight vital capacity breaths over a period of one minute.*
    - **Positive end-expiratory pressure (PEEP)**
      - *PEEP helps prevent absorptive atelectasis.*
    - **Patent airway**
      - *AO requires a patent airway in order for oxygen to reach the hypopharynx and enter the trachea.*

Complications of AO

- CO_2 is not removed during AO and as a consequence pH begins to decline.
- The rate of rise of CO_2 is approximately 3-4 mmHg per minute (Eger & Severinghaus, 1961). Therefore, ***the safe limit of AO is estimated to be <u>15 minutes</u>*** (Fraioli & Sheffer, 1973).
- Nasal cannula oxygen is delivered as a cold dry gas which can dry the nasal and respiratory mucosa. This does have the potential to cause sinus pain, mucosal dehiscence, and epistaxis.
- However, adverse effects from AO are infrequent and do not usually have clinical significance (Kolettas et al., 2014).

Literature Review

- A study of obese males found that when continuous nasal oxygen at 5 liters per minute was delivered, SpO_2 greater than or equal to 95% in the group receiving oxygen was significantly longer than those who did not receive oxygen (5.29 +/- 1.02 minutes versus 3.49 +/- 1.33).
  - The lowest SpO_2 in the group who received oxygen was greater than those who did not (94.3 +/- 4.4% versus 87.7 +/- 9.3%) (Ramachandran et al., 2010).
- A study of morbidly obese patients found that high-flow nasal oxygenation prolonged the safe apnea time by 76 seconds (40%) in morbidly obese surgical patients compared to facemask oxygenation (Wong et al., 2019).
  - Also resulted in a higher minimum SpO_2.

Literature Review, continued.

- Vlok et al. (2018) concluded that it is reasonable to employ the routine use of apneic oxygenation techniques during intubation.
- King and Jagannathan (2018) suggested that apneic oxygenation techniques should become the standard of care for obese adults.
- A narrative review by Wong et al. (2017) found that out of 12 operating room studies on the effectiveness of AO, all 12 found that AO decreased the incidence of desaturation and prolonged the duration to desaturation.
- A systematic review and meta-analysis of 10 studies with a total of 2,322 patients by Tan et al. (2017) found that AO was beneficial and reduced the incidence of oxygen desaturation during the apneic period of anesthetic induction.

THE END

Thank you for your time in viewing this PowerPoint Presentation!

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Appendix N

SPSS Output for Pre and Post-Test Results of All Respondents

T-Test

[DataSet1]

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-Test Score	6.67	24	1.274	.260
	Post-Test Score	9.13	24	1.154	.236

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Pre-Test Score & Post-Test Score	24	-.148	.490

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Pre-Test Score - Post-Test Score	-2.458	1.841	.376	-3.236	-1.681	-6.542	23	.000

Appendix O

SPSS Output Comparing Pre and Post-Test Results of CRNAs and SRNAs

T-Test

Group Statistics

	Role Type	N	Mean	Std. Deviation	Std. Error Mean
Pre-Test Score	CRNA	12	6.33	1.497	.432
	SRNA	12	7.00	.953	.275
Post-Test Score	CRNA	12	9.50	.674	.195
	SRNA	12	8.75	1.422	.411

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Pre-Test Score	Equal variances assumed	2.538	.125	-1.301	22	.207	-.667	.512	-1.729	.396
	Equal variances not assumed			-1.301	18.660	.209	-.667	.512	-1.741	.407
Post-Test Score	Equal variances assumed	6.573	.018	1.651	22	.113	.750	.454	-.192	1.692
	Equal variances not assumed			1.651	15.706	.119	.750	.454	-.215	1.715