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Non-Invasive Positive Pressure Ventilation in the Obese Patient Population an Intervention to Enhance Oxygenation: A Quality Improvement Project

Justin Smith

NON-INVASIVE POSITIVE PRESSURE VENTILATION IN THE OBESE PATIENT POPULATION: AN INTERVENTION TO ENHANCE OXYGENATION

A QUALITY IMPROVEMENT PROJECT

by

Justin Scott Smith

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Approved by:

____

Dr. Marjorie Geisz-Everson, Committee Chair
Associate Professor, Advanced Practice

____

Dr. Sat Ananda Hayden, Committee Member
Director of Clinical Information Systems, Forrest General Hospital

____

Dr. Patsy Anderson, Committee Member
Associate Professor, Advanced Practice

____

Dr. Lachel Story
Interim Chair, Department of Advanced Practice

____

Dr. Karen S. Coats
Dean of the Graduate School

Published by the Graduate School

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ABSTRACT

NON-INVASIVE POSITIVE PRESSURE VENTILATION IN THE OBESE PATIENT POPULATION: AN INTERVENTION TO ENHANCE OXYGENATION

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Obesity is a comorbidity that can be challenging to the anesthetist. Patients who are obese are at risk for rapidly desaturating after becoming apneic during the induction of a general anesthetic. This rapid desaturation is mainly attributed to their decreased oxygen reserve that is a result of their obesity. Mississippi is known to have a disproportionately higher percentage of citizens who are obese, compared to other states (Johnson, 2016). Desaturation in the obese is important to avoid because it leads to atelectasis and prolongs recovery. When an anesthetist is providing a general anesthetic to the obese patient population, it is important they use the most current evidence-based practice to prevent desaturations. In this population, current evidence-based practice and literature supports non-invasive positive pressure ventilation (NIPPV) during the period of pre-oxygenation prior to the induction of a general anesthetic. Literature supports the usage of an alveolar recruitment maneuver with the use of positive end-expiratory pressure after the placement of an endotracheal tube to further enhance oxygenation throughout surgery.

An informal survey of anesthesia providers at a hospital in Southeastern Mississippi, where a predominately large number of patients are obese, revealed that they did not use non-invasive positive pressure ventilation or alveolar recruitment maneuvers during the induction of general anesthesia. A quality improvement (QI) educational project was prepared which included a comparison of intervention study between the usage of NIPPV and normal tidal volume breathing before the induction of general anesthesia. The usage of NIPPV resulted in enhanced oxygenation as evidence by a higher saturated oxygen level (SpO2%) on arrival to the post-anesthesia care unit as compared to the preoperative recording.

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DEDICATION

I would like to thank God for seeing me through this challenging endeavor. Without his patience, love, and support I would not be where I am today. I dedicate this project to my family. To my family, thank you for your love and support during the achievement of this degree. It is because of your love and support that I was able to achieve this pinnacle degree.

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LIST OF ABBREVIATIONS

APL	Adjustable Pressure Limiting
APN	Advanced Practice Nursing
ARM	Alveolar Recruitment Maneuver
CRNA	Certified Registered Nurse Anesthetist
CT	Computed Tomography
DNP	Doctor of Nursing Practice
FeO2	Forced Expiratory Oxygen
FRC	Functional Residual Capacity
IRB	Institutional Review Board
Mg	Magnesium
NIPPV	Non-Invasive Positive Pressure Ventilation
O2	Oxygen
PACU	Post Anesthesia Care Unit
PEEP	Positive End-Expiratory Pressure
SpO2%	Saturated Peripheral Oxygen

CHAPTER I – INTRODUCTION

Overview

Obesity has become a major healthcare issue in the United States. According to the World Health Organization (WHO), there were more than 1.9 billion adults who were overweight in 2014. Of the 1.9 billion, 600 million were obese (WHO, 2014). Obesity is defined by the American Heart Association as a body mass index of 30 or greater (AHA, 2014). In Mississippi, many of the patients who present for surgery are obese. According to *The State of Obesity: Better Policies for a Healthier America*, Mississippi has an adult obesity rate of 35.6%; the rate of obesity has increased from 23.7% in 2000.

An obese patient is challenging for the nurse anesthetist because of the altered respiratory anatomy and physiology that accompanies obesity. Obese patients are at risk for desaturation during induction and in the immediate post-induction period. This drop in oxygen saturation leads to obese patients developing atelectasis and desaturation more frequently than non-obese patients (Talab, 2009).

Atelectasis contributes to significant healthcare costs for the obese patient population (Talab, 2009). The high rate of atelectasis development in this patient population results in a slower recovery time (Eichenberger, 2002). It is also important to note that the atelectasis persists for 24 hours after extubation, as opposed to the atelectasis resolving shortly after extubation in the non-obese patient (Eichenberger, 2002). Postoperative respiratory dysfunction may result from atelectasis and the patients' inability to maintain their airway (Eichenberge, 2002). The reason the obese patient has difficulty in maintaining their airway in recovery is because of the anesthesia that still resides in the body, along with the large tongue, and the excess tissue that displaces the anatomy in the posterior pharynx and larynx (Eichenberger, 2002).

The tissue displacement hinders air flow into and out of the lungs and decreases the patient's functional residual capacity (FRC). Maintaining a good functional residual capacity is important because it is the amount air that remains in the lungs at the end of passive expiration. When undergoing anesthesia, the amount of FRC in the lungs is important because it affects how long the patient has before they start to desaturate after induction. A reduction in the FRC is significant because it can lead to further atelectasis development and desaturation. When obese patients undergo general anesthesia, it is imperative that the anesthesia providers use the most current evidence-based practice that prevents a further compromise in their respiratory status.

Another important fact to consider in this population who is undergoing a general anesthetic is that a large amount of absorptive atelectasis can become present during induction (Hu, 2016). Absorptive atelectasis results when the concentration of nitrogen in the alveoli decreases to a level that prevents the alveoli from staying open. Absorptive atelectasis is significant because it can further increase atelectasis and prevent the exchange of gas from taking place in the alveoli. Preventing atelectasis is important for all patients but, with those who are more prone to its development, it is especially important to use the most current evidence-based practice to help prevent its formation.

Background and Significance

With rates of obesity on the rise, it is important for anesthesia providers to be cognizant of the most current evidence to lessen the effects of intraoperative and postoperative respiratory dysfunction. The primary purpose of this project was to provide better patient outcomes through the use of NIPPV and the secondary purpose consist of prompting CRNAs to make a practice change in the care of their obese patients who results in a safer anesthetic experience. Of the 600 billion affected by obesity, The Center for Disease Control reports that the annual medical cost of obesity in the United States is 147 billion dollars, and the annual medical cost for an obese patient versus an average weight patient is 1,429 dollars more (CDC, 2015). To help minimize these costs, advanced practice nurses and providers of anesthesia should use the latest evidence-based practice that supports improvement in this population's outcomes during and after surgery.

While pre-oxygenating the patient, the forced expiratory oxygen percentage (FeO2) is monitored for an acceptable percentage, which correlates with how effective the pre-oxygenation technique is. A FeO2 of 90% or greater is the goal, but many of times in the obese it is difficult to get it above 85%. The FeO2 is a measure of nitrogen washout because it represents the amount of oxygen in the alveoli on expiration. The endpoint in pre-oxygenation is to maximize the FeO2 with each patient. NIPPV is an effective intervention to raising the FeO2 in this patient population and it should be used by the anesthetist to gauge if the patient is ready to proceed with induction, because it represents the concentration of oxygen that the patient is expiring from their lungs, which correlates closely with the concentration that is in the lungs.

The Importance of Prolonging Apnea to Desaturation Times Through the Use of NIPPV

The obese patient has many negative respiratory physiological processes compared to the normal weight patient. One of the major differences are that there is a restrictive disease pattern in their respiratory anatomy. In this population, there is a decrease in lung volumes including but not limited to functional residual capacity, which leads to an increase in atelectasis in this patient population. An increase in atelectasis leads to a decrease in oxygen and carbon dioxide exchange, a ventilation/quality mismatch, decreased SpO2 level, and further prolongs time to extubation. Many obese patients are difficult to mask ventilate, and many times a rapid sequence induction is performed because of their severe gastric reflux. Not being able to mask ventilate a patient after a rapid drop in SpO2 puts the patients' safety at risk.

It is important that anesthesia providers do everything in their practice to prolong the apneic to desaturation period in this patient population, by increasing the FeO2 and enhancing the pre-oxygenation period with the use of NIPPV. Obese patients often have respiratory complications in the postoperative period and most often times it is associated with the high amount of atelectasis. An important fact to consider about atelectasis is that it is present for at least 24 hours after surgery in the obese population, but it disappears in the non-obese patients (Rudra, 2006). In a patient population who is already respiratory compromised secondary to their weight, preventing atelectasis is important because it leads to longer hospital stays and added health care cost.

The obese patient population is known to have an increased airway closing capacity, increased work of breathing, and increased oxygen consumption (Georgescu, 2012). All of these hinder the exchange of oxygen, carbon dioxide, and promote atelectasis. The use of NIPPV during the pre-oxygenation period reduces pressure across the diaphragm during normal tidal breathing in obese individuals and this leads to decrease work in the muscles that assist the diaphragm with breathing (Georgescu, 2012). The decrease work is beneficial because there is less energy expenditure for muscle use during the pre-oxygenation period and it allows for less usage of oxygen by the body, while more is made available in the blood. In this population, the use of NIPPV during pre-oxygenation and an alveolar recruitment maneuver (ARM) post endotracheal tube placement have been shown to have a profound beneficial impact on the respiratory physiology and oxygenation for this patient population (Futier, 2011).

To perform an ARM, after intubation, the adjustable pressure release valve is closed between 30 and 40 cmH2O and a large breath is given and held with squeezing the bag on the anesthesia machine. The breath is pressured to an inspiratory pressure between 30 and 40 cmH2O, while being held for 30 to 45 seconds. ARM's recruit alveoli that are collapsed and further opens the functioning ones which is beneficial because it enhances gas exchange at the alveolar capillary level. To keep these alveoli open, positive end-expiratory pressure (PEEP) is programmed into the anesthesia machine, and the patient is immediately placed on mechanical ventilation with the programmed PEEP after the breath hold is released.

The purpose of this intervention change was to enhance oxygenation in a population of patients who are already compromised before undergoing general anesthesia but are further compromised after the induction as previously discussed. It is through this physiological benefit of NIPPV during pre-oxygenation that the obese patients' anesthetic experience will be managed more safely. The most widely used technique in the obese patient population prior to induction of anesthesia is normal tidal volume breaths with 100% oxygen (Futier, 2011). Normal tidal volume breaths are also known as the traditional or conventional pre-oxygenation technique. With the use of this pre-oxygenation technique the patient simply takes the largest breaths they can take with a 100% oxygen flowing through a face mask.

The benefits of NIPPV compared to normal tidal volume breaths during pre-oxygenation is less episodes of desaturation. The decreased frequency of desaturation is achieved through increasing the patient's oxygen load through raising their FRC and decreasing atelectasis formation. Prolonged episodes of hypoxia can place patients in danger of developing a hypoxic event. These patients are generally more difficult to ventilate due to anatomical reasons such as increased adipose tissue as previously described. With those patients who are more difficult to ventilate, they may be at risk for developing a hypoxic event during the apneic period. A prolonged apneic period that is supported by a reasonable SpO2 and FeO2 is paramount to this population, and it can be achieved through the use of NIPPV. A reasonable SpO2 in this population during induction is 95% or greater and is supported by an FeO2 of greater than 90%. The SpO2 should be 95% and higher to promote prolonged attempts to intubation in this population (Ramachandran, 2010).

Clinical Question

The need for NIPPV and alveolar recruitment maneuvers are paramount in Southeast, Mississippi where a large portion of the population is obese (Suzan, 2016). These current interventions were not observed to be practiced at the location where this intervention was delivered. The clinical question for this project was: Does the use of NIPPV improve oxygenation of obese patients?

Purpose

The purpose of this project was to provide the most current evidence-based practice information to the anesthesia providers for a proposed quality improvement change. The primary goal of this Doctor of Nursing Practice (DNP) Project was to improve patient outcomes through the implementation of NIPPV techniques and alveolar recruitment maneuvers. The change that resulted in the use of NIPPV and alveolar recruitment maneuvers was decreased incidences of oxygen desaturations prior to endotracheal tube placement. Also, there was evidence of enhanced patient oxygenation during surgery as evidence by increased SpO2 on arrival to PACU as compared to the preoperative result. The use of NIPPV provided the anesthetist with a longer apneic to desaturation time, and in doing so there was a higher arterial oxygen concentration in the immediate post-induction period. When using this intervention, the obese patient was shown to experience a safer anesthetic experience, a higher SpO2 on arrival to the post anesthesia care unit (PACU) and a quicker recovery as current evidence-based literature supports.

Literature Review

A literature search was performed using PubMed, Google Scholar, Medline, and Primo through The University of Southern Mississippi. The literature search focused on obtaining articles related to obese patients undergoing general anesthesia, and how the use of NIPPV during the pre-oxygenation period along with alveolar recruitment maneuvers post intubation enhanced the patients' level of oxygenation. A literature review matrix is included in Appendix A. The search strategy consisted of searching the words obesity, non-invasive positive pressure ventilation, alveolar recruitment maneuver, positive end expiratory pressure, oxygenation, alveolar recruitment maneuver, pre-oxygenation period, anesthesia, and induction. The outcomes measured were patient oxygenation during the critical times for the obese patient population which are immediately prior to induction, post-induction and after extubation on arrival to PACU.

The inclusion criteria consisted of articles written in the English language that evaluated the use of NIPPV and alveolar recruitment maneuvers in the obese. The exclusion criteria consisted of any articles not written in the English language, articles not published within the last 10 years, and articles irrelevant to the proposed practice intervention. Four-hundred articles dated between May 2008 and February 2016 were found. The articles pertained to obesity, the type of ventilation techniques used during pre-induction for this population during surgery, and the effect these techniques had on oxygen saturation. They were narrowed down by year and the only ones chosen pertained to non-invasive positive pressure ventilation and the use of alveolar recruitment maneuvers.

After narrowing the articles down, there were 30 articles. After evaluating the 30 articles, 5 were found to be significant to my intervention. Each of these articles provides the supportive evidence needed to carry out the desired practice change intervention in the obese patient population. A total of 5 articles were used to create the literature review table in appendix A

Summary of Literature Review

The literature supports that NIPPV decreases the incidences of oxygen desaturation during the induction period by providing an increase in FRC and greater denitrogenation. A higher FeO2 is supported by the use of NIPPV than normal tidal volume breathing alone. A high FeO2 is important because it has been determined that the rate of oxyhemoglobin desaturation to 85% in obese patients is about 45 seconds without the use of preoxygenation, compared to 171 seconds in the non-obese patient (Hu, 2016). Also, the use of an alveolar recruitment maneuver, and the use of PEEP between 5cmH2O and 10cmH2O throughout the case resulted in better PaO2, decreased atelectasis, and faster recovery in the PACU (Talob, 2009).

Futier (2011) conducted a strong evidence-based direct observation study. In this study, it was determined; that the use of both NIPPV and an alveolar recruitment maneuver immediately after endotracheal tube placement was more effective at sustaining adequate lung volumes and oxygen saturation than pre-oxygenation alone (Futier, 2011). He compared the PaO2 immediately after the 3 minutes of pre-oxygenation amongst 3 different groups. Each group had a different method of pre-oxygenation performed. Group 1 received 100% O2 alone in which NIPPV was not used (control group). The PaO2 was drawn 3 minutes after pre-oxygenation and the results were 306+/-51mmHg. Group 2 had NIPPV performed with 100% O2 in which the PaO2 was 375 +/-82mmHg. Group 3 consisted of those who received NIPPV but also had an alveolar recruitment maneuver performed immediately after intubation. Group 3 had a PaO2 of 425 +/-64mmHg immediately after intubation. In a population who is respiratory compromised and more prone to desaturation, a greater PaO2 provides for a longer period of apnea to oxygen desaturation.

Also, immediately after endotracheal tube intubation, the PaO2 was redrawn, and the results were as follows: Group 1 had a PaO2 of 150mmHg, Group 2 had a PaO2 of 221 mmHg, and Group 3 had a PaO2 of 225mmHg that resulted. Lastly, the PaO2 was measured five minutes after the onset of mechanical ventilation, and the results were as follows: Group 1 had a PaO2 of 93mmHg +/-25mmHg, Group 2 had a PaO2 of 128 +/-54mmHg, and Group 3 had a PaO2 of 234 +/- 73mmHg. It was determined by Futier that the obese patients achieved and maintained better oxygenation when an ARM was used with NIPPV.

To further support the usage of NIPPV it was determined that in morbidly obese patients, pressure support ventilation during the pre-oxygenation period resulted in greater oxygenation compared with neutral breathing, and there were less episodes of desaturation (Harbut, 2011). Harbut discovered that the partial pressure of carbon dioxide post intubation was lower in the pressure support ventilation (PSV) group (4.9 +/-0.5kPa) compared to the neutral breathing group studied (5.2+/-0.7kPa). He found that the PSV group maintained a SpO2 range of 97-99% compared to the neutral breathing group's range of 83-99%. Also, it was determined that the PaO2 was much higher in the PSV group (32.2+/-4.1kPa) post intubation compared to the neutral breathing group's PaO2 range (23.8+/-8.8kPa) post intubation.

In 2016, Hu conducted a systematic review in which she searched databases for clinical trials for ventilation maneuvers for the obese patients. There were 13 randomized control trials that were evaluated for the obese patient undergoing bariatric surgery. In these studies, it was found that the use of NIPPV prevents further atelectasis formation during induction and prolongs the non-hypoxic apnea duration. The use of NIPPV in all studies resulted in better oxygenation compared with the conventional pre-oxygenation during induction. Also, through the use of the alveolar recruitment maneuver, the PaO2/FiO2 ratio was higher and the dynamic compliance of the pulmonary parenchyma was found to be enhanced. Enhancing the compliance of the pulmonary parenchyma is beneficial because it results in the patient maintaining adequate oxygen saturation for a longer period of time. Hu (2016) found a correlation between the use of PEEP and higher end-expiratory lung volumes that were measured by helium dilution.

A few studies reviewed, evaluated the patients' SpO2 levels in PACU and the time to patient discharge. In these studies, it was discovered that use of an alveolar recruitment maneuver immediately after intubation and the use of PEEP led to higher SpO2 readings in the PACU and earlier discharge time from the hospital. Comparing the studies that used 5 cmH20 of PEEP and those that used 10 cmH20 throughout surgery, it was determined that PEEP of 10 cmH20 showed better PaO2 intraoperatively and postoperatively, decreased atelectasis postoperatively as evaluated by computed tomography, fewer pulmonary complications; and the patients remained in the hospital for a shorter period of time.

In 2012, Georgescu studied 32 patients with a BMI greater than 30. They were randomly divided into two groups. Group 1 consisted of 16 patients who were pre-oxygenated with NIPPV, and Group 2 consisted of 16 patients who were pre-oxygenated without NIPPV before induction. Each of the patients in the study underwent 3 min of pre-oxygenation with 100% oxygen.

In Group 1, the PSV settings were an inspiratory positive airway pressure of 4 cmH20 and 4 cmH20 of PEEP. The FeO2 levels were looked at immediately after the three minutes of preoxygenation. In Group 1 the FeO2 was greater than or equal to 90% at 80% of the time. In Group 2 the FeO2 was greater than or equal to 90% at 60% of the time using normal tidal volume breathing. A FeO2 that does not reach 90% or above in this population leads to quicker desaturation, which can be detrimental for the obese patient who has an airway that is difficult to manage. A lower FeO2 results in hypoxemia faster than a higher FeO2, and with a lower FeO2, the anesthetist has less time to secure the airway.

Talab (2009) conducted a study in which 66 adult obese patients with a BMI of 30-50kg/m^2 were randomly placed into 3 groups. Group 1 consisted of normal tidal volume breathing during pre-oxygenation and then an alveolar recruitment maneuver for seven to eight seconds after intubation. Group 2 consisted of PSV during pre-oxygenation, an alveolar recruitment maneuver with a hold of 7 to 8 seconds immediately after intubation, and then the use of 5 cmH20 of PEEP throughout the surgery. Group 3 received the same treatment as Group 2, but instead of 5 cmH20 of PEEP, 10 cmH20 was used. The patient's heart rate, mean arterial pressure, and alveolar-arterial PaO2 gradient were measured intraoperatively and postoperatively in the PACU. Also, each patient had a computed tomography (CT) scan of their chest performed in the PACU to evaluate for atelectasis.

It was determined that Group 3 had better oxygenation both intraoperatively and in the PACU. This group also had less atelectasis evident on the CT scan and there were fewer pulmonary complications than the other two groups. The study concluded that the use of an intraoperative alveolar recruitment maneuver and PEEP of 10 cmH20 results in less atelectasis, enhanced oxygenation, and shorter PACU stays for the obese patient undergoing laparoscopic surgery.

Theoretical Framework

The theoretical framework that used for this DNP project was the Model for Change to Evidence-Based Practice, by Rosswurm and Larrabee (1999). This practice translational framework utilizes current research and evidence-based practice to make a practice change. In the translation process, there are six steps that must be used. The first step involves assessing the need for change in clinical practice in order to decrease the incidences of desaturation in a population who is most at risk for desaturation during the induction period of anesthesia.

The second step involves searching for interventions that can counteract the problem. The use of NIPPV and an alveolar recruitment maneuver are both supportive of decreasing the incidences of desaturation of the obese patient during the induction and post-induction period. The use of NIPPV is beneficial because it prevents hypoxemia formation in a patient who is at high risk during short apneic times. Step three incorporates the evaluation of the most current evidence-based literature, with choosing those that prove to be most effective in treating the clinical need in practice. The use of NIPPV and alveolar recruitment maneuvers have shown to be the most effective at maintaining oxygen saturation during the time in which the obese patient is most vulnerable for desaturation, induction of general anesthesia.

Step four and five involves the design of a practice change. The practice change design was carried out through the DNP project by developing an evidence-based practice change proposal that was presented to CRNAs in

PowerPoint format explaining the results of the comparison intervention study carried out by a CRNA. Last, step six involves sustaining the proposed practice change. Sustaining the practice change became evident when the CRNA who implemented the intervention decided to sustain the practice change in her care of the obese populations. The CRNAs provided the education session were important in this project because they were provided the choice of implementing and sustaining the practice change. They have the potential to put it in to use for their future practice, but, also, pass on the information to other providers who may also be willing to change their current practice.

The Donabedian model focuses on structure, process, and outcome. This model was useful for this project because it structures the formation of initiatives that are to improve the process and outcomes of care that is being delivered. The use of this model contributed to the improvement of care in the obese surgical patient and in doing so it heightened preventive measures that provided better patient outcomes. The three parts of the model are structure, process, and outcome. Structure involves the providers, resources, and physical environment where the quality improvement intervention took place. Process involved the intervention or activities that were administered from the advanced practitioner. Lastly, the outcome was the change in current or future health status that resulted from the intervention.

The Donabedian model asks of the user to evaluate the outcome of results to determine the level of improvement. If the level of improvement is significant, the usage of the intervention can be supported for future patients. The intervention that was carried out involved implementing an improvement in current health care practice, and it followed the process of non-research evaluation.

Doctor of Nursing Practice Essentials

This Doctor of Nursing Project fulfills the eight DNP practice essentials. These essentials are set forth so that advanced practice nurses (APNs) can strengthen their practice through education. The DNP practice essentials are the foundation that molds the advanced practice nurse into his or her role

Essential One: Scientific underpinnings for practice

This DNP essential allows the researcher to use evidence-based theories in order to form interventions that are able to improve the delivery of healthcare, and to then evaluate the interventions outcomes. This intervention resulted in a safer anesthetic in the obese patient population by improving their oxygenation. After the intervention was presented, the outcomes of the patients were evaluated through measuring their SpO2% on arrival to the PACU.

Essential Two: Organizational and systems leadership for quality improvement and systems thinking

This DNP essential uses evidence-based practice in nursing to develop or support different methods of care that are the most current for specific patient populations. This DNP project was designed to implement evidence-based interventions for a specific problem in the obese patient population, with its focus on the pre-oxygenation phase prior to induction and immediately after intubation.

This essential can be used to help guide the DNP into enhancing the safety for a particular patient population.

Essential Three: Clinical scholarship and analytical methods for evidence-based practice

This DNP essential calls on the advanced practice nurse (APN) to evaluate all current existing literature in order to determine an intervention that will enhance current practice. This essential also prompts the APN in practice to evaluate for outcomes in different populations. Overall, this essential helps the APN to adapt their practice based on the most current, safest, and beneficial practice findings. This essential is highly reflective in this project because analytical methods were used to evaluate current research on the effects of NIPPV and intra-alveolar recruitment maneuvers for the obese patient population. This project entailed the evaluation of research that has already been conducted by other researchers and making a review of literature that was used to prompt a practice change in a group of CRNAs in Southeast Mississippi, where there is a vast population of obese patients.

Essential Four: Information systems and technology and patient care technology for the improvement and transformation of health care

This DNP essential calls on the APN to become an expertise in the skills needed to acquire data from different informational systems and databases. Also, the ability to evaluate data and take away the most meaningful points and use it in practice is part of this essential. This essential asks of the APN to monitor and evaluate the interventions that they impose on their patients. During this project, I used these skills to develop the proposed intervention that I defended to a group of CRNAs, who then decided whether or not they were going to incorporate it into their practice when caring for this population.

Essential Five: Healthcare policy for advocacy in healthcare

This essential is needed because it prompts the APN to be a leader and implement new evidence-based practice through the development of healthcare policies at the local, state, institutional, and federal levels. This project meets this essential because it improved the quality of care for the obese patient population by enhancement of their oxygenation throughout surgery. The leadership of myself, the developing APN, was displayed through the presentation of a practice change proposal to a group of CRNAs. The practice change proposal ultimately led to changes in hospital policy and practice patterns that will benefit future patients.

Essential Six: Interprofessional collaboration for improving patient and population health outcomes

As a DNP prepared nurse, we must take part in collaborating effectively and being part of the development of new practice guidelines. Whether it is a newly developed practice model, guideline, policy, or standard, we must communicate with others effectively throughout the process in order for the intervention to adhere. Inter-professional collaboration is very important in order for a practice change to become adopted by others in the same work environment. It is the inter-professional collaboration that will promote the spread of the intervention and will help it to sustain. By providing the most current evidence-based practice to a group of CRNAs concerning the use of NIPPV and an alveolar recruitment maneuver in a population who it has shown to be beneficial, I was able to effectively demonstrate the use of inter-professional collaboration.

Essential Seven: Clinical prevention and population health for improving the nation's health

This DNP essential requires of the APN to evaluate data that will be used to implement a practice change in a population that will lead to clinical prevention. This project fulfilled this essential because its focus was on the implementation of an intervention that is supported by evidence-based literature to enhance this population's oxygenation while undergoing general anesthesia. This population who is otherwise at a disadvantage because of their different respiratory alterations as previously discussed is enhanced through the use of this intervention. This intervention was designed to clinically prevent episodes of desaturation and atelectasis in a population who this is prone in.

Essential Eight: Advanced Nursing Practice

This essential prepares the DNP nurse to be culturally sensitive when assessing health and illness in diverse populations. The therapeutic interventions that were implemented were formed around nursing and other sciences. The APN who utilizes this essential will use critical thinking skills when delivering evidence-based care that enhances patient outcomes. Through the use of this essential, I was able to use the most current evidence-based practice to propose an implementation that provides for better outcomes in the obese patient population with the consideration of being culturally sensitive.

CHAPTER II – METHODOLOGY

Design

After approval from the Institutional Review Board (IRB) from The University of Southern Mississippi (Protocol number: 17082202) and letter of support from the chief of anesthesia group the comparison intervention study was being conducted. The comparison intervention study consisted of one CRNA who agreed to provide NIPPV and alveolar recruitment maneuvers post intubation on five obese patients who presented for surgery at random. The intervention was performed on every other patient of those meeting inclusion criteria until a total of ten patients were selected. The inclusion criteria included obese patients who are classified by the American Heart Association as being obese (AHA, 2014). The exclusion criteria were obese patients who have been recently diagnosed with acute respiratory illnesses within the last 4 months, chronic obstructive pulmonary disorder, emphysema, or smokers. The intervention was provided to those who are considered clinically obese as defined by the American Heart Association as Body Mass Index (BMI) of 30 or greater and who were an ASA level 3 or less as documented in their record.

There were two groups. Group 1 was provided the intervention and Group 2 was provided the traditional pre-oxygenation technique. The data that was collected from each of the 10 patients was a preoperative oxygen saturation (SpO2%) and a post op SpO2%. Both of these recordings were on room air. The postoperative SpO2% was used to determine the effectiveness of NIPPV and

ARM's, comparing the difference between the two groups. After the pilot study was concluded an educational presentation was developed and presented to the anesthesia providers at the site.

The presentation consisted of supportive evidence and research that shows a strong correlation between the use of NIPPV and prolonged apnea to desaturation time. Also, the use of NIPPV, alveolar recruitment maneuvers, and PEEP was discussed as it enhances arterial oxygenation for longer periods of time in the obese patient. It was also discussed how the use of NIPPV results in higher SpO2% readings on arrival to the PACU. The presentation focused on decreasing the incidences of desaturation-associated events by using NIPPV during induction and an alveolar recruitment maneuver post-induction. The findings of the pilot study were provided at this time during the presentation to enhance the support of the proposed intervention. The protocol for carrying out the intervention is listed in appendix B.

Target Outcome

The primary goal of this Doctor of Nursing Practice (DNP) Project was to improve patient outcomes through the implementation of NIPPV techniques and alveolar recruitment maneuvers. The secondary goal was to elicit a practice change in a group of CRNAs, which supports a safer anesthetic experience in the obese population. The desired outcome was a practice change that may lead to improved patient safety through NIPPV and alveolar recruitment maneuvers during general anesthesia.

Data Analysis Plan

The evaluation of the data acquired was carried out through descriptive statistics, difference scores and the calculation of effect size by use of the Cohen's D. The difference score was beneficial to this project because it was an indication of the amount of change between the two groups. The Cohen's D was advantageous because it represented the effect size using the distance between two means using the standardized deviation. The Cohens D was calculated using each group's mean, sample size, and standard deviation.

CHAPTER III – RESULTS

During the 2 weeks in which the study was conducted, 5 obese patients were provided the intervention and five obese patients were provided the standard pre-oxygenation technique. Of the two groups studied, the group who received the intervention had the same SpO2% or higher in the PACU when compared to the preoperative result. The group who did not receive the standard pre-oxygenation technique resulted in and equivalent SpO2% or less on arrival to PACU when compared to the preoperative result. The following tables depict the results that were acquired when comparing the two types of pre-oxygenation techniques in the obese patients:

Table 1

Group 1-NIPPV

Patient No. (Random)	PREOP SpO2%	PACU SpO2%
1	96	100
3	97	100
5	96	98
7	95	99
9	95	99

Table 2

Group 2-Traditional Pre-oxygenation Technique

Patient No. (Random)	PREOP SpO2%	PACU SpO2%
2	100	97
4	96	96
6	97	94
8	98	95
10	96	93

The mean Spo2% in Group 1 was 99.2, meanwhile the average of Group 2 was 95. The SpO2% was averaged amongst each group and the difference score was computed by subtracting the two group's results. The resulting difference score was 4.2. This result was significant because it represents how much more effective NIPPV with the use of ARM's are at enhancing an obese patient's SpO2%, compared to the traditional technique. The difference score is an indication of the amount of change between the two groups and specifically to this study it represents a difference of 4.2%. Therefore, the NIPPV group had a SpO2% mean that was 4.2% higher than the control group.

The Cohen's D resulted in 3.32. Due to this score being larger than 2 the difference between the two groups mean is larger than 2 standard deviations. Meaning, the means are far enough apart to support the difference between the interventional group and control group, and there is something causing the difference. The difference found is a result of NIPPV and because 95% of the values lie within 2 standard deviations it is very significant.

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CHAPTER IV – DISCUSSION

Overview

By using the target outcomes as a guide, there was ease of assessing whether or not the proposed intervention met the end-goals of this project. After reviewing the results of this project, it was affirmed that the use of NIPPV and alveolar recruitment maneuvers in the obese patient population results in higher SpO2% on immediate arrival to PACU. These findings not only suggest that obese patients are better oxygenated when coming out of surgery, but are being better oxygenated during surgery. The results of this study provide for a first hand-look at the positive results that NIPPV has for this population, and further supports current evidence-based literature that urges its usage in the obese patient population.

No interventions or plans were needed to be in place for either the CRNA or patient in order to maintain safety. The CRNA or their license was not in any type of risk as this project only evaluated the type of pre-oxygenation technique that is used during the cases and the results of SpO2%. How the data was collected is listed in Appendix C. Patients were not at risk for being harmed as both NIPPV, alveolar recruitment maneuvers, and normal tidal volume breathing are equally acceptable in current practice. There were no violations of the Health Insurance Portability and Accountability Act (HIPAA) because no patient identifying information was collected.

Limitations

This comparison intervention project was voluntarily carried out by a CRNA and the intervention compared was delivered at random amongst ten patients. Given the small sample size (N=10), it is hard to determine whether or not the sample is representative of the general population. Although the sample size is small, the results are supportive of the use of NIPPV and provide supportive insight to its usage in current anesthesia practice for the obese.

Future Studies

Similar quality improvement projects would be beneficial for this patient population. The larger sample size would provide for enhanced support on the usage of this intervention. Also, a decrease in circuit pressure during alveolar recruitment maneuvers and altering the length of the ARM hold may be something to look at to see if it alters the SpO2% readings on arrival to PACU. A decrease in the PEEP would be something to look at, as it may alter the Spo2% readings on arrival to PACU as well.

The implications of this project were based on the major findings of the intervention results; obese patients maintain their preoperative SpO2% or result in a higher percentage on arrival to PACU after the usage of NIPPV. Not only is the usage of NIPPV supported in the obese as evidence by the results obtained from the interventional study, but it can also be beneficial to any population who has a restrictive pulmonary disease pattern. This intervention can be also used on any patient who the CRNA has trouble obtaining an acceptable FeO2% or SpO2% before induction of a general anesthetic.

Conclusion

After reviewing the literature, and carrying out a quality improvement project that resulted in support of NIPPV and ARM's in the obese patient population, I am confident to say that I will be using this in my practice of providing anesthesia. As advanced practitioners, it is important to educate others of the most current and up to date information on populations that are at risk while undergoing anesthesia. My hope is that future providers will see this project and utilize the results to put it into practice for their obese patients. In addition, I hope that overtime this will become a standard of care for the obese patient; because of how effective it is at enhancing the physiology of the obese patient undergoing a general anesthetic. One day, I hope that this can be made into a policy in all hospitals across the Nation, because our patients deserve the best and the most trusted care in modern anesthesia.

APPENDIX A – Literature Review Table

Table A1.

Literature Review Table

Author/Year/Title	Design	Sample/Data Collection	Findings	Limitations	Recommendations
Emmanuel Futier, M.D., Jean-Michel Constantin, M.D., Ph.D., Paolo Pelosi, M.D., (2011). Noninvasive Ventilation and Alveolar Recruitment Maneuver Improve Respiratory Function during and after Intubation of Morbidly Obese Patients	Direct Observation	Sixty-six unpremedicated obese patients were randomly allocated to receive either 100% 02 alone (n = 22) or NIPPV w/ 100% 02 (n = 22) or NIPPV w/ 100% O2 followed by an alveolar recruitment maneuver (n=22) immediately after endotracheal tube placement. All patients had a BMI greater than 46kg/m^2 and received the intervention for a total of five minutes.	Arterial O2 was measured in all groups five minutes after onset of mechanical ventilation. Group 1 (100% O2, normal tidal volume breathing)- PaO2 93mmHg +/- 25mmHg Group 2 (100% O2 w/ NIPPV)-PaO2 128mmHg +/-54mmHg Group 3 (100% O2 w/ NIPPV + Alveolar Recruitment maneuver)- PaO2 234mmHg+/- 73mmHg	No limitations listed.	A combination of pre-oxygenation w/ NIPPV and an alveolar recruitment maneuver immediately after endotracheal tube intubation more effectively maintains lung volume and oxygenation during anesthesia induction than does pre-oxygenation alone w/ 100% O2 or NIPPV.

Xin Yan Hu, MA, MSN, CRNA (2016). Effective Ventilation Strategies for Obese Patients Undergoing Bariatric Surgery: A literature review	Literature Review	Databases were systematically searched for clinical trials of ventilation maneuvers for obese patients. 13 randomized control trials for obese patients undergoing bariatric surgery were selected.	Evaluated were the effects the ventilation strategy had on PaO2, SaO2, A-aDo2, and lung atelectasis. In the 13 studies reviewed: NIPPV during the pre-oxygenation period with Alveolar recruitment maneuver immediately after ETI, and PEEP of 5-10 cm H2O throughout surgery were compared with normal tidal breathing alone or the use of NIPPV without the alveolar recruitment maneuver and without PEEP throughout the surgical procedure. It was determined that the NIPPV+Alveolar recruitment maneuver+ PEEP participants had a higher PaO2/FiO2 Ratio, a smaller A-aDo2, higher SpO2 in PACU, earlier discharge time from the hospital, greater end-expiratory lung volumes, decreased atelectasis in lung areas as evident by CT-scans in the immediate post op period, increased lung compliance, fewer pulmonary complications, and shorter hospital stays.	There were no limitations in the study.	NIPPV and the recruitment maneuver followed by PEEP is an effective ventilation strategy for bariatric surgical patients. NIPPV provides further kinetics by preventing atelectasis formation and prolonging non-hypoxic apnea duration.

P. Harbut, W. Gozdzik, E. Stjernfält, R. Marsk, and J. F. Hesselvik (2014). Continuous positive airway pressure/pressure support pre-oxygenation of morbidly obese patients	Direct Observation	44 morbidly obese patients scheduled for a laparoscopic bypass with 80% O2 for 2 minutes were randomized to receive either pressure support ventilation (a form of NIPPV) or neutral breathing without pressure support ventilation. Anesthesia was induced in Rapid Sequence Intubation protocol and the trachea was intubated without mask ventilation.	PaO2 was measured before preoxygenation, before induction, and immediately following intubation. <u>PSV group:</u> Partial carbon dioxide pressure (4.9+/-0.5 kPa) Post intubation PaO2(32.2 +/- 4.1 kPa) Nadir oxygen range (97%-99%). <u>Neutral breathing group:</u> Partial carbon dioxide pressure (5.2+/- 0.7kPa) Post-intubation PaO2 (23.8+/- 8.8kPa) Nadir oxygen range (83%-99%).	No limitations were listed	In morbidly obese patients, low pressure PSV during preoxygenation results in better oxygenation compared w/ neutral breathing, and prevented desaturation episodes.

M. Georgescu, I. Tanoubi, L.-P. Fortier, F. Donati, and P. Drolet (2012). Efficacy of Pre-Oxygenation with NIPPV in Obese Patients: Cross Over Physiological Study	Direct Observation	145 patients were evaluated with a BMI greater than 30. Of the 145, 45 were patients were recruited. 32 of the patients followed through with the study. At random the 32 patients were broken up into two groups. 16 patients were preoxygenated with the use of NIPPV and 16 patients were preoxygenated without the use of NIPPV. In the NIPPV group 4cm H20 of inspiratory pressure was used and 4cm H20 of PEEP. The Forced expiratory O2	<u>NIPPV group:</u> FeO2 greater than or equal to 90%. <u>Non-NIPPV group:</u> FeO2 less than or equal to 80%. FeO2 was achieved at greater than or equal to 90%, when using NIPPV 80% of the time. FeO2 was achieved at greater than or equal to 90% when not using NIPPV 60% of the time.	No limitations	Using NIPPV reduces trans-diaphragmatic pressure during spontaneous breathing in obese individuals, thus unloading the workload of the breathing muscles. FeO2 measures the efficacy of preoxygenation since it represents a measure of denitrogenation and oxygen wash in inside the functional reserve capacity.

		(FeO2) level was measured in both groups.			
Talab, Zabani, Abdelrahman, Bukhari, Mamoun, Ashour, Sadeq, and Sayed (2009). Intraoperative Ventilatory Strategies for Prevention of Pulmonary Atelectasis in Obese Patients Undergoing Laparoscopic Bariatric Surgery.	Direct Observation	Randomly 66 adult obese patients were selected with a BMI of 30-50kg/m^2 who were to undergo laparoscopic bariatric surgery. The patients were randomly placed into 1 of 3 different groups. The patient's heart rate,	Group 1 -Normal tidal breathing, Alveolar recruitment maneuver for 7-8s after ETI Group 2- NIPPV, Alveolar recruitment maneuver for 7-8s after ETI and PEEP of 5cmH2O throughout case. Group 3- NIPPV, Alveolar recruitment maneuver for 7-8s after ETI and PEEP of 10cmH2O throughout case.	Group 3 (NIPPV + Alveolar Recruitment maneuver + PEEP 10 cmH2O) had better oxygenation both intraoperatively and postoperatively in the PACU and less postoperative pulmonary complication	During preoxygenation, the use of NIPPV and Alveolar Recruitment Maneuver and PEEP of 10cmH2O throughout surgery is associated with preventing lung atelectasis, better oxygenation, shorter PACU stay and fewer pulmonary complications in the postop period in obese patients undergoing

		MAP, SpO2, and A-aPao2 gradient were measured intraoperatively and postoperatively in the PACU. CT scans of the chest in PACU were performed to evaluate for atelectasis.		s than group 1 or group 2.	laparoscopic surgery.

APPENDIX B –Data Collection Tool

1. Body mass index: 30-39.5

2. Male   Female

3. Preoxygenation Technique: Circle one

A. NIPPV w/ APL valve and assist w/ hand bag, Alveolar recruitment (40cmH20 X 30 seconds) maneuver, PEEP of 7cmH20
B. Normal tidal volume breathing.

4. Pre-op SpO2% on room air _________________
5. PACU SpO2% on room air _________________

APPENDIX C

Non-invasive Positive Pressure Ventilation Protocol

1. Place a tight-fitting mask with good seal over patient's mouth and nose with 100% oxygen.

2. Close the Adjusted Pressure Limiting Valve between 10 and 15cmH20 and assist the patient with each breath for 3 minutes.

3. After a forced expiratory oxygen (FeO2) percentage of 90% or better is reached, the provider can proceed with the pharmacology to induce anesthesia and perform endotracheal intubation.

4. After confirming that the Endotracheal tube is in the trachea (positive/equal breath sounds and an end-tidal carbon dioxide tracing is evident, set the ventilator settings with added positive end expiratory pressure (PEEP) at 7 cmH20. After logging the ventilator settings perform an alveolar recruitment maneuver (ARM).

To perform an ARM, close the APL valve to 40 cm H20 and squeeze the anesthesia bag to pressure the anesthesia circuit to 40 cm H20. Hold the bag squeezed with the pressure at 40 cm H20 for 30 seconds.

5. After releasing the bag, <u>immediately</u> place the patient on ventilator with pre-programmed PEEP at 7 cmH20

APPENDIX D –IRB Approval Letter

INSTITUTIONAL REVIEW BOARD
118 College Drive #5147 | Hattiesburg, MS 39406-0001
Phone: 601.266.5997 | Fax: 601.266.4377 | www.usm.edu/research/institutional.review.board

NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months. Projects that exceed this period must submit an application for renewal or

continuation.

PROTOCOL NUMBER: 17082202
PROJECT TITLE: Non-Invasive Positive Pressure Ventilation in the Obese Patient Population: A Quality Improvement Project
PROJECT TYPE: New Project
RESEARCHER(S): Justin Scott Smith
COLLEGE/DIVISION: College of Nursing
FUNDING AGENCY/SPONSOR: N/A
IRB COMMITTEE ACTION: Expedited Review
Approval PERIOD OF APPROVAL: 08/30/2017
to 08/29/2018
Lawrence A. Hosman, Ph.D.
Institutional Review Board

APPENDIX E –Letter of Support

6/22/17

[redacted], support Justin Smith's DNP project to implement a quality improvement project through the use of Non-invasive positive pressure ventilation prior to induction and alveolar recruitment maneuvers after intubation in the obese patient population. The project will take place in Magee, [redacted]

Sincerely,

[redacted]

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