ANESTHETIC IMPLICATIONS OF OBSTRUCTIVE SLEEP APNEA (OSA) IN THE ADULT POPULATION

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Abstract

The intent of this project was to assess the student nurse anesthetist's level of understanding on the anesthetic implications of patients with obstructive sleep apnea (OSA). The researchers aimed to educate this cohort on the best evidence-based practice in managing patients with OSA. There is a very high correlation between OSA and increased body mass index (BMI). As the prevalence of obesity rapidly rises in the United States, health care clinicians find themselves caring for more patients with OSA. Due to the increased prevalence of OSA, it is imperative that new clinicians have a sound knowledge of the comorbidities and the anesthetic implications that are directly related to this disease. The literature review revealed that OSA is largely under diagnosed. The literature also revealed common strategies that should be implemented perioperatively to reduce post-op complications in this specific group of patients. Research indicates that patients with OSA may be more sensitive to opioids, thus should be used sparingly. Another focus of this project was to improve screening for OSA and to better manage their anesthetic care. A pretest was administered to the participants before an educational presentation, then a posttest after the presentation was completed to measure the increase in knowledge. The pre-and posttests were graded and the statistics were analyzed utilizing a paired t-test. From the data, the researchers determined the t value is -13.347 ($p < .001$) which is statistically significant. Therefore, it can be concluded that there is a significant increase in the mean percentage values between pre-test and post-test.

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Introduction

Obstructive sleep apnea (OSA) is the most commonly undiagnosed sleep disorder in the United States and affects many patients in the perioperative setting (Lipford, Ramar, & Salim 2015). Obstructive sleep apnea affects as many as one in four men and one in ten women. It is also believed that up to half of all patients with OSA undergoing surgery are undiagnosed (Olson, Chung, & Seet, 2016). Obesity is on the rise in the United States and since there is a direct correlation with obesity and OSA, nurse anesthetists will be providing care to more and more at-risk patients. Assessing a patient's airway is crucial to their safety when administering sedation. The challenge faced when caring for patients with sleep apnea is maintaining ventilation and oxygenation. When OSA patients are sedated, they can easily obstruct, becoming hypoxic and hypercarbic. This issue goes deeper than just ventilation and oxygenation. There are multiple co-morbidities associated with sleep apnea. Patients with OSA may also have diabetes, coronary artery disease, hypertension, pulmonary hypertension and right-sided heart failure (Hines & Marschall, 2008). Having knowledge of this condition serves the anesthesia profession globally as OSA is not limited to Americans.

The experienced nurse anesthetist is proficient when instrumenting a patient's airway and is vigilant when monitoring patients under anesthesia. Obstructive sleep apnea is an independent risk factor for a difficult intubation (Lipford, Ramar, & Salim 2015). This subject should be addressed with student nurse anesthetists because they lack experience. Improving the knowledge base of student nurse anesthetists will better prepare them for managing the anesthetic of OSA patients and their transfer to the post anesthesia care unit. There are many different anesthetic approaches with a single surgery. It was the goal of these researchers to guide the anesthetist in identifying an at-risk patient, creating an anesthetic plan that focuses on

the safety of the patient, implementing the plan intraoperatively, and transferring care to the PACU nurse. The clinical problem being addressed was: how should anesthetic techniques differ in adult patients with OSA than in those without to maximize oxygenation and ventilation to avoid perioperative complications? The researchers aimed to answer the question: in student nurse anesthetists at Adventist University of Health Sciences, how much does the knowledge of anesthesia in OSA patients increase after a 30-minute PowerPoint presentation quantified by a pretest and posttest. A comparison was made after the presentation to the group of student nurse anesthetists, the goal of improving the students' knowledge was achieved.

Literature Review

Obstructive sleep apnea is defined as airflow cessation of more than ten seconds and characterized by frequent episodes of apnea or hypopnea during sleep (Hines & Marschall, 2008). Pharyngeal critical pressure (Pcrit) must remain negative to maintain tracheal patency. In patients with OSA, Pcrit becomes positive, favoring collapse (Lipford, Ramar, & Surani, 2015). Patency is also dependent on positioning, airway reflexes, and the tone of the dilator muscle, which often decreases during sleep and during anesthesia (Hines & Marschall, 2008, and Lipford, Ramar, & Surani). Hypopnea is a lower percentage of flow below baseline, which may lead to desaturation (Hines & Marschall, 2008). A diagnosis of OSA is made with overnight polysomnography with five or more episodes of hypopnea per hour (Deflandre et. al., 2016). The number of episodes per hour determines severity. Manifestations include snoring and daytime somnolence secondary to lack of consistent quality of sleep during the night. Patients with OSA will experience hypercarbia, desaturation, polycythemia, sympathetic surges, hypertension, and pulmonary hypertension, which can lead to right ventricular failure (Hines & Marschall, 2008).

They are also at high risk for heart attack, atrial arrhythmia, stroke, and sudden cardiac death during sleep (Lipford, Ramar, & Surani, 2015).

There is a strong correlation between obesity and the development of OSA. Airway narrowing and closure in obese patients is related to large neck circumference and pharyngeal tissues. Craniofacial skeletal abnormalities and tonsillar hypertrophy causes OSA in those who are not obese (Hines & Marschall, 2008).

Patients with OSA undergoing surgery are more likely to undergo perioperative complications than those without. In one study, patients were shown to have a 46% higher incidence of perioperative complications than the control group and 63% higher rate in a second study (Lipford, Ramar, & Surani, 2015). The literature is also clear that 80% of patients affected by OSA are undiagnosed and many who are diagnosed are noncompliant with treatment. Untreated OSA has been proven to increase risk for serious postoperative complications even further (Lipford, Ramar, & Surani, 2015).

Respiratory complications such as pneumonia and atelectasis are common in patients with OSA, exacerbation of other comorbidities may also occur. Postoperatively, OSA patients have been shown to be at an increased risk for atrial fibrillation, encephalopathy, hypotension, infection, bleeding, and chest pain (Lipford, Ramar, & Surani, 2015). They are also less likely to participate in ambulation second to drowsiness. If patients are more tired they are likely to participate less in physical therapy, which can slow their recovery. Complications related to OSA and surgery often happen days postop but most commonly postop day three (Lipford, Ramar, & Surani, 2015 & Chung et al., 2014). These complications lead to longer PACU stays, more unplanned admissions to the intensive care unit (ICU), longer hospital stays, and require more

intense monitoring. One study revealed that major postoperative complications lead to a greater than $11,000 higher hospital bill (Lipford, Ramar, & Surani 2015).

Better screening may help identify patients who are affected by OSA to allow for safer anesthetic care and help avoid complications (Lipford, Ramar, & Salim, 2015, Olson, Chung, & Seet, 2016, and Deflandre et. al., 2015). It is highly likely that the student nurse anesthetist will encounter numerous patients who suffer from sleep apnea as they present for various types of surgical procedures. The current method to screen for OSA is the STOP-BANG questionnaire. This method assesses snoring, tiredness, observed apnea, blood pressure, BMI, age, neck circumference, and gender. Answering yes to three or more questions means the patient is at increased risk for sleep apnea (Deflandre et al., 2016). With the rush of operating room turnover, this may not always be accurately assessed. The STOP-BANG questionnaire also depends on having a patient who can accurately answer the questions. Asking subjective questions like, “do you feel tired?”, may be answered differently based on culture and language barrier. It has also been shown to be a poor predictor of perioperative complications in patients with OSA (Deflandre et al., 2016, and Schumann et al., 2016).

The DES-OSA score is an easy, accurate screening process to be utilized by anesthesia clinicians to better predict perioperative complications versus the STOP-BANG questionnaire alone (Deflandre et al., 2015). This screening process is quick and is based on morphologic criteria that is more consistent with the nurse anesthetist’s assessment. The DES-OSA score assesses mallampati score, thyromental distance, BMI, and sex in addition to the STOP-BANG criteria. The gold standard to diagnose sleep apnea remains a sleep study with polysomnography but often patients have never had one. The STOP-BANG questionnaire is useful but should be modified as ≥5 indicators are a better predictor of perioperative complications related to OSA

(Deflandre et al., 2015). Modifying or adding to the STOP-BANG criteria and educating providers on the screening process can help better identify OSA patients (Deflandre et al., 2015). It may also help the provider design a more specific anesthetic plan to diminish potential perioperative complications.

Along with improving the screening process, intra-op care can be improved. Once a patient is identified as having OSA or is a high risk for OSA, the anesthetic management can be tailored toward them. Due to the anatomic changes of their airway, they are likely to be a more difficult intubation, especially for the student nurse anesthetist (Lipford, Ramar, & Surani, 2015). Patients with OSA have been shown to be more sensitive to preoperative sedation and therefore more likely to obstruct. That is why it is generally not advised to pre-medicate these patients with anxiolytics. It is important for the nurse anesthetist to understand techniques to optimize ventilation in these patients. Proper positioning prior to induction is very helpful. Placing the patient in sniffing position or ramping prior to intubation is crucial.

During the surgery, the nurse anesthetist should be knowledgeable of different anesthetic strategies to optimize the patient. Patients with OSA are likely to have pulmonary hypertension therefore, hypoxia and hypercarbia need to be avoided. This population is at a high risk to obstruct while they are breathing spontaneously without an advanced airway This is especially important during moderate/deep intravenous sedation, as obstruction of the airway may be masked by the supplemental oxygen.

It is important for the nurse anesthetist to understand techniques to optimize these patients. Proper positioning is very helpful. Supine position also increases the likelihood of airway closure and should be avoided when possible (Lipford, Ramar, & Surani, 2015). Utilizing a jaw thrust can relieve obstruction during moderate/deep sedation anesthesia cases. The current

literature mentions using continuous positive airway pressure (CPAP) during moderate/deep sedation cases to optimally ventilate these patients (Olson, Chung, & Seet, 2016). The use of nasal trumpets and oral airways are also essential in preventing obstruction. Some providers may prophylactically insert a nasal trumpet after induction to assist with ventilation during the procedure after extubation.

Schumann et al. (2016) tested a device that can measure respiratory volumes with similar accuracy to that of the ventilator in patients without advanced airways. This device could help anesthesia providers monitor the ventilation status in patients not on a ventilator intraoperatively and in the PACU. Singh & NS (2016) presented a case study suggesting that patients with severe OSA have a BIPAP on or available during sedation cases.

Pain control is a very important strategy to be discussed with the student nurse anesthetist. Hypoxia associated with OSA may activate inflammatory pathways, which enhances pain and the endogenous opioid response (Lam et al. 2016). This makes these patients more sensitive to narcotics and their respiratory depressing side effects both during the perioperative period and days after (Lam et al. 2016). The literature widely supports a multimodal approach to pain control utilizing regional with local anesthetics, gabapentin, pregabalin, robaxin, NSAIDS, Ofirmev and NMDA antagonists (Lipford, Ramar, & Surani, 2015). Alpha-2 antagonists, such as precedex and clonidine, are great drugs that are underutilized in patients with OSA. Precedex gives great sedating effects and relieves anxiety without respiratory depression. Precedex is a promising drug that can be implemented in the multimodal approach to pain management in patients with OSA. Improving the knowledge of student nurse anesthetists can better guide them on utilizing all of their resources around them to formulate the best anesthetic plan.

Short-acting medications are generally preferred in patients with OSA (Lipford, Ramar, & Surani, 2015). Desflurane is often utilized due to its low lipid solubility as compared to sevoflurane. Remifentanil is a short acting narcotic that will not linger in the patient. This provides excellent pain control for the procedure without the long acting respiratory depression as seen with other narcotics.

When extubating a patient with OSA, they should be as awake as possible and following commands. If they are extubated while still deeply sedated, they may not be able to maintain their airway. The safest way to extubate a patient is with the head slightly elevated, fully awake, and following commands while closely assessing respiratory effort and tidal volumes. If the anesthetist has given a paralytic, he or she should ensure that the paralytic is fully reversed prior to extubation. The anesthetist should carefully assess the patient's muscle strength through various tests such as train of four, head lift and negative inspiratory force. Residual muscle relaxation can be detrimental and leads to delayed extubation, hypoxemia, longer PACU stays and other respiratory complications (Olson, Chung, & Seet, 2016).

After the initial anesthetic is done, patients are brought to the PACU. By limiting long acting narcotics the chance of severe respiratory depression in the PACU is reduced. Patient controlled analgesia may be a better choice in patients with OSA (Lipford, Ramar, & Surani, 2015). If the patient uses a CPAP machine at home, it should be available for the patient after the procedure. Continuous pulse oximetry monitoring in the PACU is a standard of care as well as oxygen therapy as needed. It is important to note that although a patient appears well oxygenated, they may still be hypercarbic. Monitoring respirations during the postop period is standard but monitoring ETCO2 has been shown to be a better indication that a patient is well ventilated, especially in patients with severe OSA. Assessing the patient after giving report to the

PACU nurse is extremely important and part of the continuity of care the anesthesia provider gives.

In reducing post-op complications, one must remember that this at-risk population may return to the nursing floor where the staff is not able to closely monitor the patient. Protocols need to be in place as care transitions from anesthesia and surgery to bedside care. Having a firm understanding of the process from start to finish with the focus on patient safety needs to be part of the anesthetic plan for patients with OSA.

Contribution and Dissemination/Justification

The goal of this project was to shed light on this problem via education and emphasize how OSA is an overlooked topic in anesthesia. The target population that was directly addressed was the student nurse anesthetists of Adventist University of Health Sciences, class of 2018 and 2017. The specific focus of this project was to reveal the need to better identify patients with OSA and to be more effective with their ventilation and oxygenation. The aim was to also help student nurse anesthetists formulate a more appropriate anesthetic plan for the surgery in hopes it will directly reduce complications. The project emphasized how the anesthetic plan carries consequences into the post-op period in PACU and to the surgical unit where staff nurses will be giving care. This educational presentation was disseminated November 2, 2017.

Project Aims

The aim of this project was to improve the student nurse anesthetists understanding of anesthetic implications in the care of OSA patients so they can implement safe and effective care in the clinical environment. These researchers achieved this goal at the end of an educational presentation presented by two senior nurse anesthesia students. The researchers saw an increase

in scores between pretest and posttest by greater than 10 percent. This was determined through statistical analysis via a paired T-test.

Project Methods

The researchers based the project's methodology on the administration of a pre- and post-test after the educational presentation. The pre- and posttest was approved by the IRB. All students were properly informed of the study and they signed an informed consent prior to administration of the pretest. When all of the participants were assembled, the pretest was administered without any prior education or introduction of the topic of discussion. The test was administered all at once and proctored to retain validity of the results. During the lecture, students were instructed to not write anything down to prevent them from answering test questions during the lecture. The pretests were also picked up prior to beginning the presentation. Statistical analysis was performed with the acquired results via a paired t-test. A P-value was obtained through the data collected.

The participant's identity was protected. The only participants were those in the nurse anesthesia program at Adventist University of Health Sciences, class of 2017 and 2018. No personal identifiers were used on the pre-and posttests thus the researchers evaluating the results did not know who answered what questions incorrectly. This methodology encouraged students to answer questions to the best of their ability without fear of judgment from staff or researchers. Informed consent was given to all participants and they were required to sign a waiver to participate in the study.

The study was performed during the fall semester of 2017. This was the most appropriate time to educate the student nurse anesthetists because they will have a sound foundation of knowledge of anesthesia based on the didactic courses they have taken.

The data collected was not stored on any personal electronic devices such as phones or laptops. The paper copies were stored under lock and key in the project chairs office. Only the project chair had a key to the office. Once the results were obtained and the statistical analysis was performed the researchers personally place the pre- and posttests in a paper shredder to 100% ensure protection of the student's privacy. The tests were destroyed 11-8-17.

Project Timeline

The timeline of this project was laid out in the syllabus of MSNA690. This project was divided across three academic trimesters. Trimester one had deadlines for forming a research topic, obtaining an academic mentor and chair along with formulating a scholarly project proposal. The researchers were responsible for doing CITI modules to be in compliance with the IRB by May 31, 2017. The researchers formulated pre-and posttest questions that were submitted to the IRB along with their project proposal. The ADU IRB/SRC application form was submitted by June 30, 2017 and approved September 25, 2017. The educational presentation was created during the time allotted by the faculty, July 31st to August 3rd. The project was implemented November 2nd, 2017. The final PowerPoint presentation was submitted to the project chair for approval prior to the end of trimester 6. The presentation of the poster project to disseminate the information was performed April 9, 2018. Close contact was maintained with project mentor every two to three weeks. Completion of the scholarly paper final draft with was submitted by February 23, 2018.

Data Collection Plan

The researchers collected the data personally. The pretest was administered to the nurse anesthesia students. After all the tests were returned and counted the researchers presented the educational PowerPoint. The PowerPoint was thirty minutes in length. The posttest was

administered and proctored to ensure validity and no group collaboration can occur to ensure the most accurate results. The tests were picked up and counted by the researchers once again and the data was taken for analysis. The students had fifteen minutes to complete the 10-question posttest. Students were directed to only answer questions by themselves as they would any other proctored test. No talking was permitted during the examination process.

Evaluation Plan

The project was evaluated objectively based on data obtained from pre-and posttests. The test consisted of 10 questions that were approved by the IRB committee. The pretest determined the baseline knowledge of the students on the subject of OSA. The posttest quantitatively measured an increase in knowledge of the material after the education. The posttest was administered immediately after the educational PowerPoint presentation. This ensured the information was still fresh in the minds of the student nurse anesthesia cohort. SPSS is the program that was used to do the statistical analysis. The results were statistically analyzed using a paired t-test. This determined that the educational presentation was effective at increasing the student's understanding of OSA and aid in the integration of better anesthetic management of this patient population.

Results/Findings

The pretest was used to demonstrate the student's initial knowledge of the subject. The results were obtained by utilizing a paired T test. The post-test revealed that the students' knowledge on the anesthetic implications of obstructive sleep apnea significantly increased after the administration of a thirty minutes educational PowerPoint. The results of the pre-test showed the participants scored an average of 36.6%, with a standard deviation of 12.08% and a standard error mean of 1.74%. The results of the post test revealed an average score of 69.3%, with a

standard deviation of 12.44%. The standard error mean was 1.79%. The results of the Paired T test analysis showed a standard deviation between the pre-and post-tests of -32.70833% with a standard error mean of 16.98 %. The T value obtained was -13.347 with a p value less than 0.001 level of confidence. The statistical analysis supports that there was a significant level of knowledge increase following the administration of the educational presentation. Scores increased on average from the pretest to posttest by nearly 33 percent which surpassed the researcher's expectations based on current limitations. Full values and table is included in the appendix C.

Limitations/Conclusion

Unfortunately, there are limitations in this study. The students were presented with information after a long day in clinical. Many participants openly admitted they were very fatigued and distracted by the many deadlines and course work for the upcoming week. This evidence shows the students were likely fatigued and had a shorter than normal attention span. The sample size was also small, consisting of just 48 students. Coupled with the small sample size and over worked participants the implementation phase of the project was not ideal. Roughly half of the students were senior students who have a better base knowledge of anesthesia, including both didactic and clinical experience. Testing senior and junior students at the same time might have affected the results since the junior students had far less clinical hours in the operating room. There were also limitations of the researchers. Neither researcher had prior experience in conducting research although, this was slightly offset by the utilization of a knowledgeable and experienced mentor.

Despite these limitations, the researchers were able to conclude that the thirty minutes educational presentation did in fact, significantly increase the participants knowledge on this

topic. Scored improved from the pre-test to posttest by 32%. The results were validated by a p value less than .001. It was evident to the researchers that there was a deficit of knowledge on the management of OSA in the adult population based the pre-test scores. Based on the rigorous didactic course work these students are put through the researchers expected an overall higher average on the pre-test.

Interestingly, the participants overwhelming surpassed expectations on the post test. The researchers set forth a goal to improve knowledge on posttests by 10 percent when in fact, overall scores increased by greater than 30 percent. The researchers attribute this meaningful increase in knowledge to the fact that participants were exposed to their knowledge deficit in the pre-test so they were more focused when the presenters covered the topic in detain.

The results of this project support the need to continue to further educate student nurse anesthetist students in this area of expertise. This study shows that the students were very receptive to the information and significantly increased their knowledge in just thirty minutes. The future effects of this increase in knowledge cannot be directly determined via the data collected but it is reasonable to assume that the students are better informed on the subject to clinically manage patients with OSA. The researchers hope this information will indirectly reduce morbidity and mortality in this population.

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Appendix A

ADU NAP CAPSTONE PROJECT – INFORMED CONSENT

Our names are Joseph Stanga and Jeffery Burrington, and we are MSNA students in the Nurse Anesthesia Program (NAP) at Adventist University of Health Sciences (ADU). We are doing a Capstone Project called *ANESTHETIC IMPLICATIONS OF OSA IN THE ADULT POPULATION*. This project is being supervised by Manuel Tolosa, DNAP, CRNA. We would like to invite you to participate in this project. The main purpose of this form is to provide information about the project so you can make a decision about whether you want to participate.

WHAT IS THE PROJECT ABOUT?

The purpose of this project is to assess student nurse anesthetist's level of understanding on the anesthetic implications of patients with obstructive sleep apnea (OSA) and to educate this cohort on the best evidence-based practice in managing patients with OSA.

WHAT DOES PARTICIPATION IN THIS PROJECT INVOLVE?

If you decide to participate in this project, you will be asked to complete an anonymous pre-assessment, attend a classroom presentation, and then complete an anonymous post-assessment. The assessment will measure the increase in knowledge of the subject being presented as compared to the pretest. Your participation by attendance at the presentation and completion of the survey is anticipated to take approximately 45 minutes.

WHY ARE YOU BEING ASKED TO PARTICIPATE?

You have been invited to participate as part of a convenience sample of students currently enrolled in the ADU NAP. Participation in this project is voluntary. If you choose not to participate or to withdraw from the project, you may do so at any time.

WHAT ARE THE RISKS INVOLVED IN THIS PROJECT?

Although no project is completely risk-free, we don't anticipate that you will be harmed or distressed by participating in this project.

ARE THERE ANY BENEFITS TO PARTICIPATION?

We don't expect any direct benefits to you from participation in this project. The possible indirect benefit of participation in the project is the opportunity to gain additional knowledge about anesthetic implications to better treat patients with OSA.

HOW WILL THE INVESTIGATORS PROTECT PARTICIPANTS' CONFIDENTIALITY?

The results of the project will be published, but your name or identity will not be revealed. To maintain confidentiality of assessments, the investigators will conduct this project in such a way to ensure that information is submitted without participants' identification. There will not be any participant identifiers on the pre-or posttests. All of the tests will be stored in the project chair's office which will remained locked. After the data has been collected and the results have been analyzed, the tests will be destroyed in a paper shredder within a week.

WILL IT COST ANYTHING OR WILL I GET PAID TO PARTICIPATE IN THE PROJECT?

Your participation will cost approximately 45 minutes of your time, but will require no monetary cost on your part. You will not be paid to participate.

VOLUNTARY CONSENT

By signing this form, you are saying that you have read this form, you understand the risks and benefits of this project, and you know what you are being asked to do. The investigators will be happy to answer any questions you have about the project. If you have any questions, please feel free to contact Joseph Stanga and Jeffery Burrington at Joseph.Stanga@my.adu.edu and Jeffery.Burrington@my.adu.edu, respectively. If you have concerns about the project process or the investigators, please contact the Nurse Anesthesia Program at (407) 303-9331.

_____

Participant Signature/ Participant Name (PRINTED LEGIBLY)

_____

Participant Name (PRINTED LEGIBLY)

Date _____

Appendix B

Questionnaire

Questions

1. All are assessed in the OSA STOP BANG questionnaire except?
   A. Gender
   B. Age
   C. Neck circumference
   D. Daytime activity

2. Which comorbidities in not associated with obstructive sleep apnea?
   A. Pulmonary Hypertension
   B. Hypertension
   C. Polycythemia
   D. Coronary artery disease
   E. Left heart failure

3. What medication is not a safe choice for pain control in a patient with OSA?
   A. Ofirmev
   B. Toradol
   C. Dilaudid
   D. Remifentanil
   E. Regional with local anesthetics
   F. Ketamine

4. Patients with sleep apnea benefit from what strategies?
   A. Using short acting medications
   B. Avoiding narcotics
   C. Using desflurane when not otherwise contraindicated
   D. All of the above

5. Precedex _____ the amount of opiate required by synergistically working on Mu receptors.

   A. Increases
   B. Decreases
   C. Has no effect on
   D. Depends on the gender of the patient

6. The DES-OSA score assesses all of these morphological characteristics except?
   A. mallampati score
   B. thyromental distance
   C. BMI
   D. Neck circumference
   E. Gender

7. What percent of patients affected by OSA are undiagnosed?
   A. 20%
   B. 40%
   C. 60%
   D. 80%

8. All of the following are effective strategies to increase ventilation and oxygenation in an OSA patient except?
   A. Oral airway
   B. Nasal trumpet
   C. Non-rebreather mask
   D. Jaw thrust
   E. Home CPAP machine

9. What is the best indicator of ventilation in the PACU?
   A. ETCO2
   B. Continuous pulse oximetry
   C. Chest rise
   D. Hand over the mouth

10. Perioperative respiratory complications in patients with OSA peak when?
    A. Immediately postop
    B. POD 1
    C. POD 2
    D. POD 3

Appendix C

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	VAR00001	36.6667	48	12.08715	1.74463
	VAR00002	69.3750	48	12.44669	1.79653

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	VAR00001 - VAR00002	-32.70833	16.97803	2.45057	-37.63824	-27.77843	-13.347	47	.000

The paired samples t test was conducted to analyze the data. The obtained t value is -13.347 ($p < .001$), which is statistically significant. Therefore, it can be concluded that there is a significant increase in the mean percentage values between pre-test and post-test.

Appendix D

Anesthetic Implications Of Obstructive Sleep Apnea

JEFFERY BURRINGTON, RN, BSN, SRNA
JOSEPH STANGA, RN, BSN, SRNA
PROJECT MENTOR ANDY MATTISON, MSNA, CRNA
PROJECT CHAIR MANUEL TOLOSA, DNAP, CRNA

Objectives

- Assess the student nurse anesthetist's level of understanding on the anesthetic implications of patients with obstructive sleep apnea (OSA)
- Educate this cohort on the best evidence-based methods in managing patients with OSA.

Clinical problem

- How should anesthetic techniques differ in adult patients with OSA compared to those without to avoid perioperative complications?

Problem Statement

- Obstructive sleep apnea (OSA) is the most common undiagnosed sleep disorder in the United States and affects many patients in the perioperative setting. The challenge faced when caring for patients with sleep apnea is maintaining ventilation and oxygenation.

Prevalence

- 1:4 Men
- 1:10 Women
- Directly correlated with obesity
- Obesity is continuously on the rise in America
- 80% of patients with OSA undergoing surgery are undiagnosed

(Lipford Ramar & Surani, 2015)

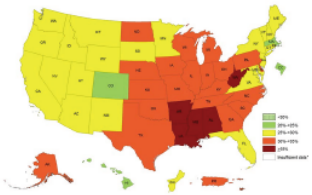
(Fig. 1)

Obesity and OSA

- Worldwide obesity has more than doubled since 1980
- In 2014, more than 1.9 billion adults 18 years and older, were overweight. Of these, over 600 million were obese.
- 39% of adults aged 18 years and over were overweight in 2014, and 13% were obese

(Obesity, 2017)

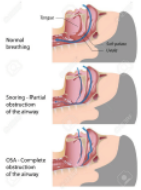
Prevalence of obesity



(Fig. 2)

Obstructive Sleep Apnea

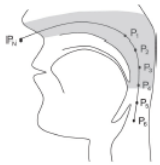
- Obstructive sleep apnea is defined as airflow cessation of more than ten seconds and characterized by frequent episodes of apnea or hypopnea during sleep
- Genioglossus muscle relaxation causes tongue to obstruct airway
- Tensor palatine muscle relaxation causes soft palate to obstruct airway



(Hines & Marschall, 2008)

Pharyngeal Critical Pressure

- Pharyngeal critical pressure (Pcrit)
- Critical closing pressure where airway collapses
- Must remain negative to remain tracheal patency
- In OSA, Pcrit becomes positive, favoring collapse



(Lipford Ramar & Surani, 2015)

Ventilation is the problem

- Keep in mind that supplemental oxygen may be masking hypoventilation
- The pulse oximetry will maintain adequate readings while the patient is becoming hypercarbic

Alveolar Gas Equation

Fraction of inspired oxygen, 0.21 in room air

$PaCO_2$ from the ABG

$$P_AO_2 = (FIO_2 \times (P_{atmos} - P_{H2O})) - \left(\frac{PaCO_2}{RespQ}\right)$$

Partial pressure of alveolar oxygen

Respiratory quotient, which is usually 0.8

Atomspheric pressure: 760mmHg at sea level

H_2O vapour pressure in the alveolus: its usually 47mmHg at 37°

(Nagelhout & Plaus, 2014)

Supplemental oxygen masks hypoventilation

Normal PAO2= 0.21 x (760-47)- 35/0.8= 105.98 mmHg

Hypercarbic patient = 0.21 x (760-47)- 70/0.8= 62.23 mmHg

Supplemental oxygen== 0.40 x (760-47)- 70/0.8= 197.7 mmHg

Supplemental oxygen Masks hypoventilation and hypercarbia !!!!!

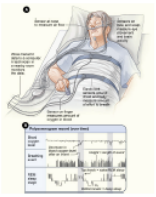
(Nagelhout & Plaus, 2015)

Manifestations

- Snoring
- Daytime somnolence secondary to lack of consistent quality of sleep during the night
- Patients with OSA undergoing surgery are more likely to undergo perioperative complications than those without

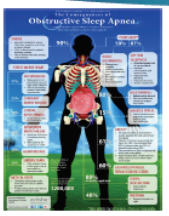
Diagnosis

- A diagnosis of OSA is made with overnight polysomnography with five or more episodes of hypopnea per hour
- OSA is defined as apnea-hypopnea index (AHI) >10 events/hr while supine
- Hypopneas were defined as a ≥30% reduction in flow associated with an arousal or a 3% desaturation. Apneas were defined as a >10 s cessation of airflow



(Defiandre et al, 2016)

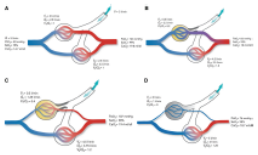
Systemic Involvement



- Diabetes
- Coronary Artery Disease
- Hypertension
- Pulmonary Hypertension
- Right-Sided Heart Failure

Pulmonary hypertension

- May have history of right sided heart failure
- Hypoxia and hypercarbia cause pulmonary vasoconstriction
- Increased workload on right side of heart
- Exacerbated during sedation when the patient becomes vasodilated (dropping preload) while also hypercarbic and hypoxic.



(Hines & Marschall, 2008)

Screening

- Snoring
- Tiredness
- Observed apnea
- Blood Pressure
- BMI
- Age
- Neck Circumference
- Gender

What Do You Do if OSA Is Suspected: STOP-BANG

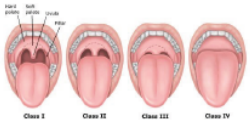
STOP Questionnaire	BANG
Snoring	BMI>35
Tiredness	Age >50
Observed you stop breathing	Neck circumference >40 cm (>15.7")
Blood Pressure	Gender male

High risk: Yes to ≥3 items → Refer for sleep testing

(Defiandre et al, 2016)

DES-OSA

- Mallampati Score
- Thyromental Distance
- BMI
- Sex
- Neck Circumference



(Defiandre et al, 2016)

Complications

- Patients with OSA have a 46-63% increased risk for perioperative complications
  - Untreated OSA increases risk even further
- Complications often happen days postop but most commonly, postop day three

(Lipford Ramar & Surani, 2015)

Complications

- Exacerbation of existing comorbidities
  - Increased risk for atrial fibrillation, encephalopathy, hypotension, infection, bleeding, and chest pain
- Respiratory complications
  - Pneumonia and atelectasis
- Less likely to participate in ambulation secondary to drowsiness

(Lipford Ramar & Surani, 2015)

Complications

- Longer PACU stays
- Unplanned ICU admissions
- Longer hospital stays
- More intense monitoring
- Average of greater than $11,000 increase in hospital bill

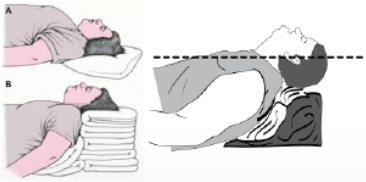
(Lipford Ramar & Surani, 2015)

Anesthetic Considerations

- Independent risk factor for difficult intubation (optimal positioning)
- Caution with preoperative anxiolytic
- Use short acting medications
- Avoid hypoxia and hypercarbia due to pulmonary hypertension
- Avoid long acting narcotics

Optimize positioning during sedation

- Sniffing position
- Ramping when obese
- Supine position increases likelihood of obstruction

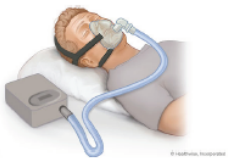


Techniques during sedation to prevent obstruction

- Nasal trumpets
- Chin lift, jaw thrust with mod-deep sedation
- Oral/nasal airways
- LMA

CPAP during mac sedation

- Utilizing CPAP during mac/moderate /deep sedation
- PSV pro on ventilator



(Olson, Chung, & Seet, 2016)

Pain Control

- Hypoxia associated with OSA may activate inflammatory pathways, which enhances pain and the endogenous opioid response
- Patients more sensitive to narcotics and their respiratory depressing side effects both during the perioperative period and days after
- Literature widely supports a multimodal approach to pain control utilizing regional, local anesthetics, Gabapentin, Pregabalin, Robaxin, NSAIDS, Ofirmev and NMDA antagonists

(Fig. 3)

(Lam et al. 2016) (Lipford, Ramar, & Surani, 2015)

Understanding The Pain Response

- Respiratory depression is a potentially dangerous complication of opioid therapy
- OSA severity is largely determined by compensatory mechanisms that are stimulated to relieve the obstruction
- Pharyngeal dilator muscles receive input from 3 different sources that stimulate airway opening
  - Central respiratory drive (decreased 02 and increased CO2)
  - Local negative airway pressure during inspiration (negative pressure reflex)
  - Wakefulness Drive (cortical arousal)

(Lam et al. 2016)

Understanding The Pain Response (cont…)

- Patients with OSA rely heavily on arousal to restore airflow
- Opioids inhibit chemical, behavioral, and motor control of respiration that could further raise already blunted arousal thresholds
- Raising arousal thresholds increases obstruction time and hypoxia

(Lam et al. 2016)

Intermittent Hypoxia and Sleep Deprivation

- Could enhance the pain response by activating complex inflammatory pathways (more sensitive to pain)
- Sleep deprivation has been shown to increase spontaneous pain in experiments possibly due to to expression of hyperalgesic inflammatory mediators
- Studies link chronic hypoxia with reduced opiate needs
- Connection between intermittent hypoxia and up regulated Mu receptors, thus increased risk for respiratory depression

(Lam et al. 2016)

Intermittent Hypoxia and Sleep Deprivation

- The chronic inflammatory state that OSA patients experience enhance pain and potentiate the analgesic effects of opioids
- Some of these mechanisms are still not fully understood and are likely multifactorial
- It is challenging finding a balance in a patient who is more sensitive to pain while also more sensitive to narcotics
- Further studies need to be performed to more accurately predict patient's response to opioids

(Lam et al. 2016)

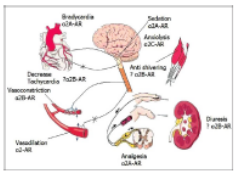
Remifentanil

- Short-acting medications are generally preferred in patients with OSA
- Remifentanil is a short acting narcotic
- Helps achieve optimal pain control during surgery
- Allows for a more judicious titration of longer acting narcotics at the end of the procedure when the patient is emerging
- Clinical tips
  - Be aware of post op hyperalgesia, truncal rigidity
  - Make sure all the medication has been flushed from IV prior to emergence

(Hines & Marschall, 2008)
(Olson Chung & Seet,2016)

Precedex Alpha 2 agonist

- Sedating effects and relieves anxiety without respiratory depression
- Utilizing precedex allows the anesthetist to use less narcotics
  - α 2-AR agonists produce clinical effects after binding to G-Protein-coupled α 2-AR, of which there are three subtypes (α 2A, α 2B, and α 2C) with each having different physiological functions and pharmacological activities. These receptor subtypes are found ubiquitously in the central, peripheral, and autonomic nervous systems, as well as in vital organs and blood vessels.



(Olson Chung & Seet,2016)

Extubation

- As awake as possible and following commands
- Airway reflexes intact
- Closely assess respiratory effort and tidal volumes
- Sitting up in bed
- Paralytic fully reversed prior to extubation
- Assess muscle strength through various tests such as train of four, head lift and negative inspiratory force
- Residual muscle relaxation can be detrimental

(Olson, Chung, & Seet, 2016)

PACU

- Home CPAP should be available
- Continuous pulse oximetry with O2 PRN
- Monitoring ETCO2 has been shown to be a better indication that patient is well ventilated, especially with severe OSA
- Patient controlled analgesia (PCA) may be a safer alternative for pain management
- Regional anesthesia is a great option to avoid pain while avoiding respiratory side effects

(Lipford Ramar & Surani, 2015)

After PACU

- Patient may not be as closely monitored on the floor than they are in PACU
- Peak post-op complications post-op day 3
- Protocols for continuum of care are helpful in this at risk population
- Educate the staff, have a discussion about post op pain control in this population

(Lipford Ramar & Surani, 2015)

Questions

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