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# Nebulized Magnesium in the Acute Treatment of Asthmatics in the Pediatric Population

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**Abstract**

Acute asthma exacerbations in the pediatric population can produce catastrophic consequences in the perioperative period. As anesthesia providers, the best airway assessment and management should be guided by evidence-based research to provide appropriate care. Current research indicates common first-line agents may result in persistent asthmatic symptoms. New research is aimed at the use of nebulized magnesium to help with climbing health care cost, improved patient safety, and resolve respiratory complications associated with asthma. Studies examined the use of nebulized magnesium independently of additional first-line bronchodilating agents compared to the use of established treatment regimens. The scholarly project team found supporting research relating the efficacy of nebulized magnesium in conjunction with other first-line bronchodilating agents, to observe the theoretical benefits of a multimodal approach to acute asthma exacerbation. The purpose of this scholarly project was to increase the knowledge base of 22 student nurse anesthetists in the 2019 cohort at Adventist University of Health Sciences regarding a multimodal approach involving magnesium during acute asthma exacerbations. A 30-minute power point regarding the use of magnesium for asthma exacerbations versus traditional treatment modalities was provided. Prior to the presentation, a pretest was distributed to the participants and immediately after the lecture, an identical post-test was dispersed to determine an increase in competency. A paired sample t-test was employed for analysis and a predetermined p-value of $<0.05$ to determine significance. The power point presentation correlated with an increased knowledge base as evidenced by a difference of 29.52% between pre-test and post-test results and a p-value of $<0.001$.

## Table of Contents

## Introduction

Asthma is a chronic lung disease with respiratory complications resulting in airflow obstruction that can lead to bronchospasm, mucous secretion, and reflex coughing. Asthma affects 334 million people globally, with increasing incidence in westernized nations (Global Asthma Report [GAR], 2014). It affects approximately 14% of the world's pediatric population and accounts for the 14th most prevalent disorder in terms of extent and duration of disability (GAR, 2014). In the United States pediatric population, asthma affects about six million children and accounts for 700,000 pediatric emergency department visits annually (Center for Disease Control [CDC], 2018; Schuh et al., 2016). Asthma is also responsible for 13.8 million school absenteeism with financial burdens that exceed $56 billion of combined direct and indirect costs (American Lung Association, 2018; Hossein et al., 2016; Sarhan, El-Garhy, Ali, & Youssef, 2016; Schuh et al., 2016). In Florida, asthma affects approximately 725,000 children under the age of 18 (Dudley & Forrest, 2013). More specifically, Orlando is considered the 64th most challenging large city in which to live with asthma due to environmental and social factors such as pollen count, air quality, public smoking laws, poverty rate, uninsured rate, and school accessibility to inhalers. Asthma, as a diagnosis, as well as management of acute exacerbations, presents the anesthesia provider with unique challenges.

Anesthesia negatively contributes to a child's already impaired respiratory status because of intraoperative patient positioning, anesthetic agents, and ventilation modes (Trachsel, Svendsen, Erb, & von Ungern-Sternberg, 2016). Anesthesia also affects a child's upper airway patency, bulbar function leading to de-recruitment, and lung compliance changes (Trachsel et al., 2016). After induction, the functional residual capacity is reduced most significantly in infants, contributing to atelectasis (Trachsel et al., 2016). Those at greatest risk of respiratory compromise are the premature because of increased collapsibility of upper and lower airways and a reduced surface area for gas exchange potentially resulting in respiratory failure during anesthesia (Trachsel et al., 2016). Those with asthma have an increased incidence of bronchospasm, laryngospasm, and asthma-related death, particularly in ear, nose, and throat cases (Regli & Von Ungern-Sternberg, 2014). In fact, a quarter of all cardiac-related deaths in the pediatric population are related to respiratory issues, particularly laryngospasm (Trachsel et al., 2016). Therefore, optimizing an asthmatic patient is key to prevent respiratory compromise and minimize intra-op adverse events.

Anesthesia providers are considered experts at managing a patient’s airway, recognizing airway complications, and being familiar with the medications that can optimize patient conditions, especially during asthma attacks. First line agents such as albuterol, ipratropium, and systemic corticosteroids may not be effective in up to 30% of the pediatric population resulting in refractory asthma with systems necessitating hospitalization (Hossein et al., 2016). The use of nebulized magnesium independently or adjunctively with first-line agents has been shown to improve patient outcomes and is relatively inexpensive. Research depicts that the use of aerosolized magnesium in conjunction with bronchodilation agents decrease overall hospitalization and expenses (Albuali, 2014).

Asthma causes bronchial hyperresponsiveness due to a number of irritants leading to reversible airflow obstruction. A detailed patient assessment should be performed in order to assess patients at risk of airway irritability which can lead to challenges in the perioperative stage. Asthmatic conditions can be quantified by the use of pulmonary function tests; therefore, there would be a decrease in the forced expiratory volume in 1 s, decreased peak expiratory flow rate from the patient’s normal value, and elevated fraction of exhaled nitric oxide. The anesthetist can expect to see an increased functional residual capacity greater than the 95th percentile which suggests air trapping, increased total lung capacity leading to hyperinflation and volu-trauma, and abnormal flow-volume loops (Irvin, Barnes, & Hollingworth, 2018).

The investigation into the efficacy of magnesium has shown rapid bronchodilation with appropriate dosing concentrations in the presence of refractory asthma attacks where first-line agents are ineffective. Magnesium inhibits release of acetylcholine from cholinergic nerve terminals, causing bronchodilation via inhibition of cellular calcium uptake, mast cell degranulation, and increases the affinity of beta receptors via upregulation (Sarhan et al., 2016). Therefore, research demonstrates decreased hospitalization, improved lung function, and a reduction in the incidence of side effects of first-line bronchodilating agents (Sun et al., 2014).

## Problem Statement

Complications caused by asthma can result in catastrophic outcomes in the perioperative period. It is essential for anesthesia providers to be aware of presenting symptoms and empirical research to apply the best evidence-based practice for the care of pediatric patients with acute asthma conditions. Evidence has shown despite the effectiveness of first-line agents, 30% of pediatric patients are resistant to initial bronchodilation treatment (Schuh et al., 2016).

Research into the use of intravenous or nebulized magnesium is increasing, due to the benefits of the treatment outcomes, as well as cost, eventually leading to improved patient satisfaction. Intravenous and nebulized magnesium have been closely investigated as treatment options due to the advantage of a faster onset, reduced side effects, well-tolerated bronchodilation effects, reduced cost, and relative availability (Agbim, Wang, & Moon, 2018; Albuali, 2014).

Florida Hospital is a large tertiary care provider in Orlando, Florida. Pediatric care is provided for more than 35 varied specialties and the institution is recognized nationally for its pediatric surgical program (Florida Hospital for Children, n.d.). With Florida Hospital's robust pediatric surgical program, it is likely that ADU SRNAs will provide anesthetic care for pediatric patients that may also have a concurrent diagnosis of asthma. Therefore, the purpose of this scholarly project was to increase the knowledge base of ADU SRNA's regarding the use of nebulized magnesium as an adjunct to the treatment of an acute exacerbation of asthma in the perioperative period.

## Project Questions

Two questions were developed using PICOT framework, to aid in the systemic review of the literature and the development of an educational intervention. The first question: In pediatric patients (P), how does the use of nebulized magnesium (I), compared to traditional asthmatic treatment modalities (C), affect asthma exacerbations (O) was used to guide the literature review. The second question: In the Adventist University student registered nurse anesthetists (P), does a 30-minute (T) power point presentation regarding the use of magnesium for asthma exacerbations versus traditional treatment modalities (I) result in-an increase in the knowledge base (O) will be used to guide the educational intervention.

## Literature Review

Currently, clinical practice for student nurse anesthetists regarding asthma is limited to the use of albuterol in conjunction with corticosteroids. Unfortunately, as stated above, up to 30% of patients with asthma do not respond to ordinary treatment, therefore adjunctive treatments must be explored to establish readily available, low-cost medications to assist in the perioperative management of the asthmatic pediatric patient that is resistant to traditional treatment modalities (Hossein et al., 2016; Schuh et al., 2016).

**Cost Effectiveness**

Magnesium has a 75% decrease in overall cost it has led to lower admission rates, reduced need for a chest x-ray, and need for blood test collection (Petrou et al., 2014). The cost of magnesium is approximately 27 cents United States Dollars compared to salbutamol which is just over two USD and dexamethasone retailing for $41 USD (Alansari et al., 2015; Drug Bank, 2018; Rebollar, Palacios, Guerrero, Torres, & Thomas, 2017). A decreased hospital stay for asthma patients in a current state of acute exacerbation results from the use of magnesium due to the benefits of improved pulmonary function tests such as forced expiratory volume in one second at 10 and 20 minutes after a single dose of magnesium combined with albuterol (Alansari et al., 2015). As opposed to albuterol in saline independent of additional bronchodilating agents, this method of treatment has resulted in faster short-term benefits in children with asthma exacerbations (Mahajan, Haritos, Rosenberg, & Thomas, 2004). Additionally, the use of intravenous magnesium administration during the first hour of patient admission through the emergency department or perioperatively has reduced the probability and risks associated with mechanical ventilation (Albuali, 2014).

**Morbidity and Mortality**

The anesthesia provider must have heightened vigilance and should note the patient's respiratory status which may not be fully optimized due to the possibility of infection, pain, fluid shifts, recent smoking, or trauma. Magnesium sulphate (1.2-2 grams intravenous venous) can be helpful in these cases as it is readily available and aides in smooth muscle relaxation (Alansari et al., 2015; Albuali, 2014; Eizaga, Palacios, Guerrero, & Thomas, 2017). When asthmatic patients undergo general anesthesia with invasive airway management, respiratory complications may arise, leading to life-threatening consequences. As a result, morbidity and mortality, as well as traumatic brain injury may occur in one in every 250 patients particularly in those with hypomagnesemia (Danz, Hinkelbein, & Braunecker, 2012; Woods & Sladen, 2009).

Since morbidity and mortality increase with asthma, the need for improved treatment options is important. Respiratory-related events account for three quarters of perioperative incidents in pediatric anesthesia and 50% of cardiac arrests (Regli & Ungern, 2015). If standard treatments are not enough to alleviate the hindering effects of asthma and bronchospasm that ensue, the use of mechanical ventilation or even extracorporeal life support may be necessary for acute asphyxia asthma.

**The Perioperative Period**

Pediatric patients are plagued with recurrent cyclical upper respiratory infections yielding an unpredictable induction and emergence. When coupled with asthma, it provides serious implications for anesthetists that begin with a full preoperative assessment of contributing factors. Anesthetic agents should be selected to ensure safe transition into and out of the operating room. Standards of care require the anesthetist to remove or avoid factors that may cause airway irritability throughout the perioperative period (Rajesh, 2015).

Preoperative pulmonary function in asthmatics can be quantified numerically using pulmonary function tests such as the forced expiratory volume in one second and peak expiratory flow rate. A numerical value of less than 80% for FEV1 and a PEF less than 50% of normal is consistent with respiratory compromise suggesting a narrowing of the airways which is congruent with severe asthma (Kokturk et al., 2005).

Kokturk et al. (2005) and Do, (2013) explained that the patients that benefitted the most from the use of nebulized magnesium in conjunction with other first-line agents were patients with severe symptoms from asthma. Quantification of severe asthma correlates to PEFR of less than 40-50%; most studies exclude participants with predicted PEFR of less than 40%, limiting the research to only patients with mild to moderate symptoms of asthma. (Kokturk et al., 2005).

Intraoperatively, pediatric asthma may have serious life-threatening implications that involve airway reactivity. Despite the improvements in anesthesia techniques and knowledge regarding this pathology, anesthetists must stay vigilant to prevent acute situations such as bronchospasms intraoperatively (Rajesh, 2015). Asthmatic triggers in the operating room include endotracheal tube insertion, airway manipulation, copious secretions, cold dry air, crying, and situations that can be perceived as stressful events (Albuali, 2014).

Treatment of acute asthma perioperatively and across other disciplines have been limited to the use of salbutamol and corticosteroids. Intraoperatively, anesthetists would use a combination of treatments that include albuterol, corticosteroids, ketamine, and anesthetic gases. Conventional treatment of asthma in the pediatric population can result in persistent bronchospasm not responsive to first-line agents (Hossein et al., 2016; Schuh et al., 2016). The use of nebulized magnesium as an adjunct agent to established treatment regimens has yielded inspiring results that validate its use as a first line option.

Research into the use of nebulized magnesium has determined that it results in bronchodilation via the inhibition of calcium ion influx from the respiratory smooth muscle cells, acetylcholine release from cholinergic nerve terminals, histamine release from mast cells, and sodium metabisulfite (Sarhan et al., 2016). The study has also brought to attention the increased affinity of beta receptors to agonists or by upregulation of receptors (Bessmertny et al., 2002; Sarhan et al., 2016).

**Therapeutic Dosing**

Dosing of nebulized magnesium has been controversial; most trials use a dose of 150 mg or 2-3 ml of nebulized magnesium sulphate (Sun et al., 2014). The use of 2-2.5 ml of nebulized magnesium helped those with initial oxygen saturation less than 92% (Sun et al., 2014; Wong, Lee, Turner, & Rehder, 2014). The use of inhaled magnesium reduces histamine and methacholine-induced bronchial hyperreactivity, leading to improved peak expiratory flow rate in as little as five minutes. Additionally, the use of 225 milligrams of magnesium with salbutamol has shown greater improvement than salbutamol in conjunction with saline (Nannini, Pendino, Corna, Mannarino, & Quispe, 2000). Hossein et al., (2016) performed a randomized clinical trial that depicted that a combination of salbutamol in isotonic magnesium sulfate has both subjective and objective advantages in health care. Using magnesium as an adjunct also decreases the amount of albuterol necessary for the dose required to achieve therapeutic relevance, this is ideal as the use of excess albuterol can result in paradoxical bronchospasm (Woods & Sladen, 2009).

Advantages of combining magnesium to standard treatment include decreased dyspnea scores, decreased use of accessory muscles of respiration, diminution of adventitious breath sounds with pulmonary auscultation, attenuation of a high pulse, coughing and respiratory rate (Hossein et al., 2016; Marzban, Haddadi, Naghipour, Sayah Varg, & Naderi Nabi, 2014). The study has also shown a reduction in the rate of hospitalizations from the emergency department after a multimodal treatment regimen involving the use of nebulized magnesium in the patient suffering from moderate to severe asthma attacks.

Hossein et al., (2016) achieved these results with a preparation of 2.5mg of salbutamol, 0.5mg of Atrovent, 50mg of oral prednisolone, with 3 ml of 260mmol/L. The study also achieved comparable results with the use of higher dosages of nebulized magnesium. The team used a 2.5ml solution of 4% magnesium that accounted for 100mg in each milliliter of isotonic magnesium sulfate. They administered the nebulized magnesium sulfate preparation in combination with 3 ml of salbutamol at 30-minute intervals for a total of four doses and found greater improvements in FEV1 in patients that previously has FEV1 of less than 30% of normal (Sarhan et al., 2016).

The common thread among the success of the use of nebulized magnesium can be attributed to the use of higher dosages. Many studies choose to administer smaller dosages to limit the potential for an adverse reaction from the use of magnesium. Adverse reactions associated with extremely large dosages of magnesium include nausea, vomiting, flushing, thirst, hypotension, drowsiness, confusion, loss of deep tendon reflexes, muscle weakness, respiratory depression, and cardiac dysrhythmias (Albuali, 2014). Overdosing on magnesium sulfate can lead to catastrophic complications perioperatively and across all disciplines in health care that would necessitate immediate treatment with endotracheal intubation accompanied by artificial ventilation, intravenous calcium chloride administration, and if necessary, initiation of advanced cardiac life support protocols. Despite the potential pitfalls of magnesium sulfate, in its nebulized form, the stated side effects have not yet occurred. Hossein et al., (2016) and Sarhan et al., (2016) used slightly higher dosages than the norm to achieve the results in the study and did not place their participant in harm’s way.

## Contribution and Dissemination/Justification

The target population of this scholarly project was 22 second year SRNAs at Adventist University of Health Sciences. Education regarding the pharmacological treatment for asthmatics is valuable due to the prevalence of asthma in modern society in the pediatric population. Added knowledge can prepare the student anesthetist for their clinical rotation in pediatrics, leading to better patient treatment and fewer adverse consequences. The new pharmacological acquaintance can be of value when care is needed to treat an asthma attack particularly when resistant to first-line treatment. The knowledge regarding nebulized magnesium is limited as this treatment modality is underutilized at Florida Hospital clinical rotation sites. The utilization of a Microsoft PowerPoint as well as a poster presentation in this scholarly project provided the SRNAs an opportunity to increase their knowledge base regarding the use of nebulized magnesium in conjunction with other first-line agents for acute asthma exacerbations.

## Project Aims

The purpose of this scholarly project was to increase the knowledge base of the 2019 SRNA cohort enrolled at Adventist University of Health Sciences about the use of nebulized magnesium as a part of a multimodal approach to the treatment of refractory asthma in pediatric patients. An identical pre and post-test was administered in conjunction with a PowerPoint presentation.

## Project Methods

A 30-minute Microsoft PowerPoint presentation regarding the perioperative use of nebulized magnesium for asthmatic exacerbations was presented based upon the literature review. Inclusion criteria included a convenience sample comprised of full-time second-year nurse anesthesia students enrolled in the Fall 2018 MSNA 504 Clinical Conference course.

Exclusion criteria were students who did not show up on time, were absent, or refuse to sign the consent form.

This scholarly project took place after approval of the Scientific Review Committee/Institutional Review Board. An identical quantitative 10 question pre and post-test was handed out to assess knowledge, as well as a voluntary informed consent to read and sign. Examiners did not allow students to write their names to protect privacy. In order to compare exam pre and post results, a number was assigned to each envelope containing the exams. After the PowerPoint presentation, an identical multiple-choice posttest was completed by the 21 students. Exam papers were later locked in a cabinet, accessible only by the project team members. Electronic information is password protected and stored on a personal computer of a project team member. The information was sent to Dr. Lukman for quantitative analysis using a paired sample t-test with a predetermined p-value of $<0.05$. After data analysis, exams were shredded, and electronic information was permanently deleted from the team members personal computer's hard drive.

**Timeline**

The scholarly project was introduced in the second week of May 2018 and was completed by May 2018. The scholarly project's implementation phase was introduced during the PowerPoint presentation in the Fall of 2018. Upon initiation of the PowerPoint presentation, data was collected via the pretest and students were reassessed post presentation. In the Spring of 2019, data analysis was completed, with the results and conclusion of the scholarly project formulated and interpreted. The results were then be integrated into the scholarly project poster presentation and the final draft of the scholarly paper.

## Data Collection

The 21 participants in this scholarly project were SRNAs from Adventist University of Health Sciences' class of 2019 Nurse Anesthesia Program. There was a total of six exchanges between participants and presenters. The exchange of information included the distribution and collection of the informed consent, the pre-test, and the post-test to the participants then back to the presenters.

## Evaluation Plan

The 10-question pre and post-tests was graded and transferred to an Excel spreadsheet. An analysis was made to compare baseline knowledge regarding nebulized magnesium and post-exam scores. Dr. Lukman, a statistician, used a SPSS program within two weeks after obtaining identical quantitative 10 question pre and post-test values to complete the statistical analysis. A statistically significant increase in scores from pretest to posttest would indicate the presentation was able to increase knowledge regarding the topic. The results and conclusion were derived from the statistical analysis and integrated into the scholarly project paper.

## Results/Findings

Exclusion criteria included one absent student from the 2019 Nurse Anesthetist Program cohort, thus 21 participants (N=21) were involved in this study. The pretests were administered per project guidelines to assess the 2019 Nurse Anesthetist Program cohort's knowledge base regarding nebulized magnesium in the acute treatment of pediatric asthma exacerbations. The findings were acquired via the use of a paired T-test to establish if there was an increase in knowledge based by comparing pre-test and post-test scores. These results suggest the use of a thirty-minute power point presentation regarding the use of nebulized magnesium for the treatment of pediatric acute asthma exacerbations, as demonstrated by a thirty percent increase in post-test results. Pretest scores averaged 41.4% with a standard deviation of 19.04%, and standard error mean of 4.15%. Posttest scores averaged 70% with a standard deviation of 9.95%, and standard error mean of 2.17%. The results of the Paired T test analysis showed a standard deviation between the pre and posttest of 18.8% with a standard error mean of 4.1%. The T-value attained was -7.183 with a p-value of less than 0.001 level of confidence. Therefore, it can be concluded that the average scores increased significantly between pretest and posttest administrations.

## Conclusions/Limitations

There are several limitations associated with this scholarly project. First, the participant sample size is small at 21 student nurse anesthetists. Secondly, time to perform this scholarly project was limited to a trimester in a Nurse Anesthesia Master's degree program, with the PowerPoint presentation being further limited to a single class period. Additionally, the presentation was provided to students that just completed a full clinical day, where fatigue may have played a part in their decreased attention span. Participation in this study mandates completion of post-test evaluation immediately after the presentation. There is not enough time between the presentation and post-test to truly measure the transfer of knowledge between the presenters and the participants.

Per the initial results from the evaluation process, the scores correlated with limited understanding of the subject as evidenced by the low average pretest scores. However, posttest scores demonstrated an increase in knowledge based that can be attributed to the thirty- minute Power Point presentation on the use of nebulized magnesium in the acute treatment of pediatric asthma exacerbations. With the increase in posttest knowledge base, the researchers are optimistic that the nurse anesthetist students will implement the use of nebulized magnesium to reduce morbidity, mortality, and cost in the pediatric population in the clinical setting.

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**Appendix A**

**ADU NAP CAPSTONE PROJECT – INFORMED CONSENT**

We are two Masters Level Nurse Anesthetist Students in the Nurse Anesthesia Program (NAP) at Adventist University of Health Sciences (ADU). We are doing a Capstone Project called *Nebulized Magnesium in the Acute Treatment of Asthmatics in the Pediatric Population*. This project is being supervised by our project chair. 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 increase the knowledge base of the Student Registered Nurse Anesthetists at Adventist University of Health Sciences about the efficacy of nebulized magnesium in the treatment of acute asthma in pediatrics.

**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 address students knowledge about the treatment of acute asthma in the pediatric population with nebulized magnesium Your participation by attendance at the presentation and completion of the survey is anticipated to take approximately 50 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. Your participation in this study is voluntary. You may choose to not to participate. The decision to participate or not participate in this research study is completely up to you. If you choose not to participate your refusal to participate in this research study will involve no penalty or loss of benefits to you. If you choose to participate, you can change your mind later and withdraw your consent and discontinue participation from this study at any time. If you chose to withdraw informed the PI of your wishes.

**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 the use of nebulized magnesium in the treatment of an acute asthma attack in pediatrics.

**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. Pre-assessment and post assessments will be placed in a locked drawer to protect the participants identity. A numbering system will replace the need for the participants names to compare pre-assessment and post assessment values. Thus, the investigators will not have access to any participants' identities. Once results are obtained, the assessment paperwork will be shredded.

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

Your participation will cost approximately 50 minutes of your time, but will require no monetary cost on your part. You will not be paid to participate.

**VOLUNTARY CONSENT**

You do not have to participate in this research study and choosing not to participate in this study will not involve any penalty or loss of benefit to you. The decision to participate or not participate in this research study is completely up to you. If you choose to participate, you can change your mind later and withdraw your consent and discontinue participation from this study at any time. If you chose to withdraw from the study informed the PI of your wishes.

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 the private investigators and assigned project chair. If you have concerns about the project process or the investigators, please contact the Nurse Anesthesia Department at (407) 303-9331.

_______________________________________________________ **Date** __________________

**Participant Signature/ Participant Name (PRINTED LEGIBLY)**

________________________________________________ **Participant Name (PRINTED LEGIBLY)**

# Appendix B

## Pre-Test and Post-Test Questionnaire

1. Magnesium works on which receptors?
    a. Inhibition of Calcium uptake
    b. Counteracts histamine
    c. Beta 2 agonist
    d. Inhibits release of acetylcholine from cholinergic nerve terminals
    e. All the above
2. Which of the following are potential asthma triggers?
    a. Cold air
    b. Crying
    c. Copious secretions
    d. All of the above
3. How many annual emergency room visits are related to asthma attacks in the pediatric population?
    a. 100,000
    b. 350,000
    c. 500,000
    d. 700,000
4. How does asthma physiologically affect a pediatric airway?
    a. Decreased upper airway patency
    b. Lung compliance changes
    c. Irreversible airflow obstruction
    d. A and B
5. Regarding pulmonary function tests, what would be seen in a pediatric patient with an asthma exacerbation?
    a. Increase in the forced expiratory volume in 1s
    b. A decrease in functional residual capacity
    c. An elevated fraction of exhaled nitric oxide
    d. None of the above
6. What are the benefits of magnesium?
    a. 75% cheaper than other medications
    b. Increased incidence of side effects of first line bronchodilators
    c. Improved FEV1 at 10 and 20 seconds
    d. A and C
7. What percentage of pediatric patient’s cardiac arrest because of respiratory related issues?
    a. 10%
    b. 25%
    c. 30%
    d. 65%
8. All of the following occur with an asthmatic patient except?
    a. Normal flow volume loops

   b. Bronchial hyperresponsiveness
   c. Increased functional residual capacity
   d. Increased total lung capacity

9. In how many minutes will inhaled magnesium reduce bronchial hyperreactivity?
   a. 2.5 minutes
   b. 5 minutes
   c. 7 minutes
   d. 9 minutes
10. Treatment for magnesium toxicity includes all the following except (select all that apply)
    a. Calcium Chloride IV
    b. Artificial ventilation
    c. Potassium Administration
    d. Insulin Administration

## Appendix C

### Pre-Test and Post-Test Questionnaire Answer Key

1. Magnesium works on which receptors?
    a. Inhibition of Calcium uptake
    b. Counteracts histamine
    c. Beta 2 agonist
    d. Inhibits release of acetylcholine from cholinergic nerve terminals
    e. All of the above
2. Which of the following are potential asthma triggers?
    a. Cold air
    b. Crying
    c. Copious secretions
    d. All of the above
3. How many annual emergency room visits are related to asthma attacks in the pediatric population?
    a. 100,000
    b. 350,000
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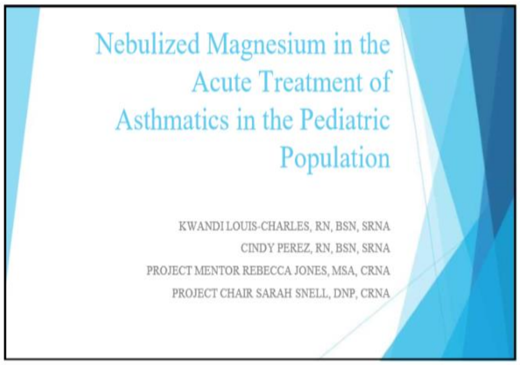
4. How does asthma physiologically affect a pediatric airway?
    a. Decreased upper airway patency
    b. Lung compliance changes
    c. Irreversible airflow obstruction
    d. A and B
5. Regarding pulmonary function tests, what would be seen in a pediatric patient with an asthma exacerbation?
    a. Increase in the forced expiratory volume in 1s
    b. A decrease in functional residual capacity
    c. An elevated fraction of exhaled nitric oxide
    d. None of the above
6. What are the benefits of magnesium?
    a. 75% cheaper than other medications
    b. Increased incidence of side effects of first line bronchodilators
    c. Improved FEV1 at 10 and 20 seconds
    d. A and C
7. What percentage of pediatric patient's cardiac arrest because of respiratory related issues?
    a. 10%
    b. 25%
    c. 30%
    d. 65%
8. All of the following occur with an asthmatic patient except?
    a. Normal flow volume loops

   b. Bronchial hyperresponsiveness
   c. Increased functional residual capacity
   d. Increased total lung capacity
9. In how many minutes will inhaled magnesium reduce bronchial hyperreactivity?
   a. 2.5 minutes
   b. 5 minutes
   c. 7 minutes
   d. 9 minutes
10. Treatment for magnesium toxicity includes all the following except (select all that apply)
   a. Calcium Chloride IV
   b. Artificial ventilation
   c. Potassium Administration
   d. Insulin Administration

## Appendix D

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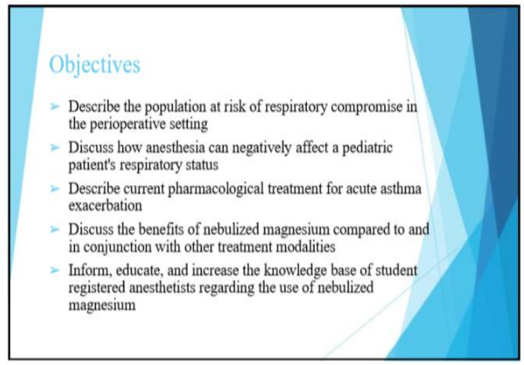


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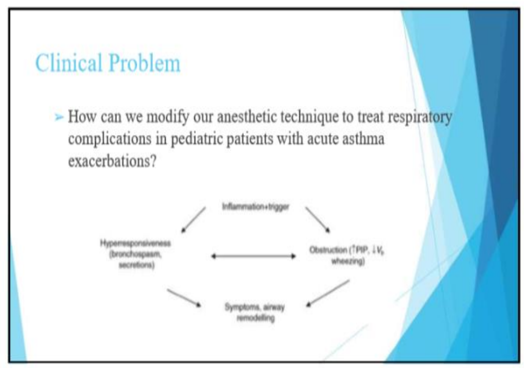


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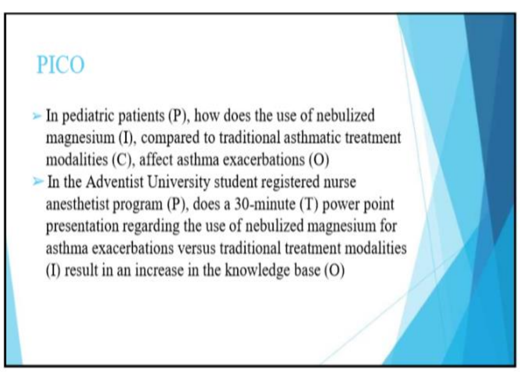


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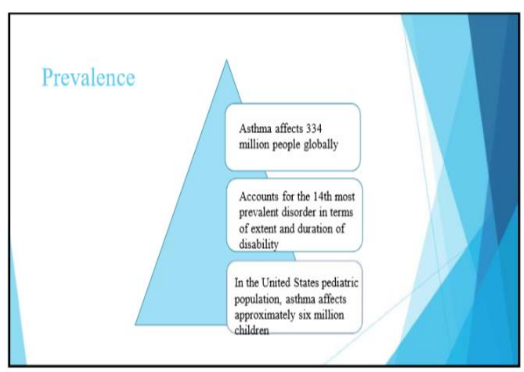


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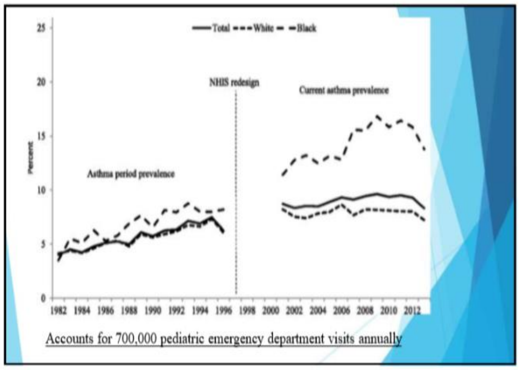
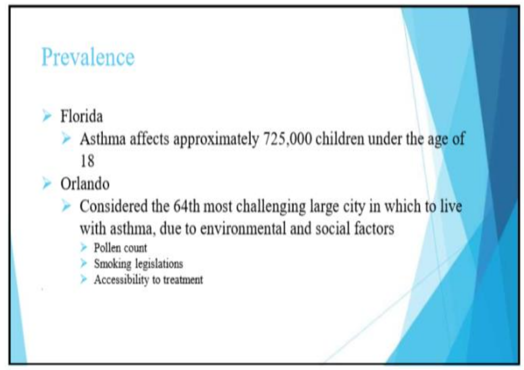
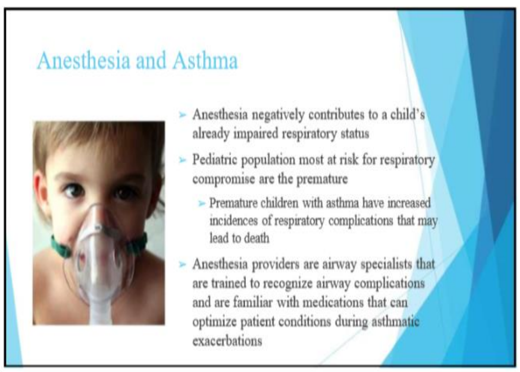

Total White Black
25
20
15
10
5
0
Percent
NHIS redesign
Current asthma prevalence
Asthma period prevalence
1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012
Accounts for 700,000 pediatric emergency department visits annually

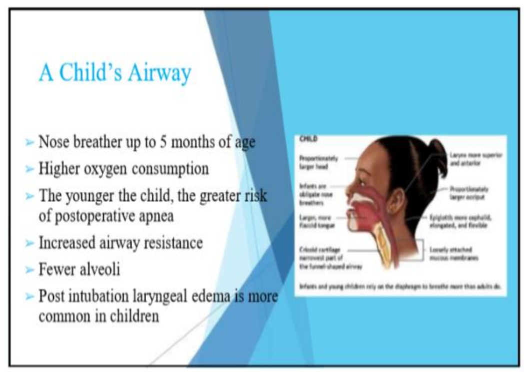
7


Prevalence
Florida
Asthma affects approximately 725,000 children under the age of 18
Orlando
Considered the 64th most challenging large city in which to live with asthma, due to environmental and social factors
Pollen count
Smoking legislations
Accessibility to treatment

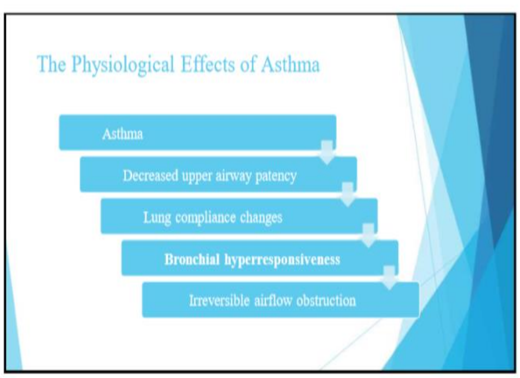
8


Anesthesia and Asthma
Anesthesia negatively contributes to a child's already impaired respiratory status
Pediatric population most at risk for respiratory compromise are the premature
Premature children with asthma have increased incidences of respiratory complications that may lead to death
Anesthesia providers are airway specialists that are trained to recognize airway complications and are familiar with medications that can optimize patient conditions during asthmatic exacerbations

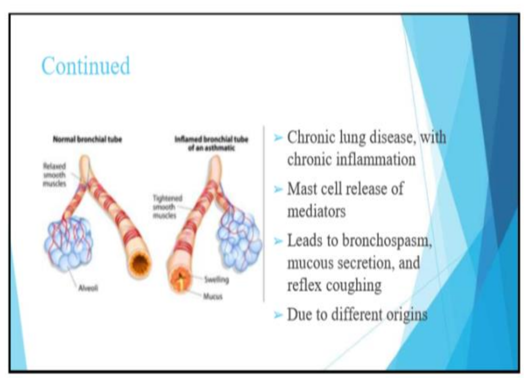
9


A Child's Airway
Nose breather up to 5 months of age
Higher oxygen consumption
The younger the child, the greater risk of postoperative apnea
Increased airway resistance
Fewer alveoli
Post intubation laryngeal edema is more common in children
CHILD
Proportionately larger head
Infants are obligate nose breathers
Larger, more flaccid tongue
Cricoid cartilage narrowest part of the funnel-shaped airway
Larynx more superior and anterior
Proportionately larger occiput
Epiglottis more cephalid, elongated, and flexible
Loosely attached mucous membranes
Infants and young children rely on the diaphragm to breathe more than adults do.

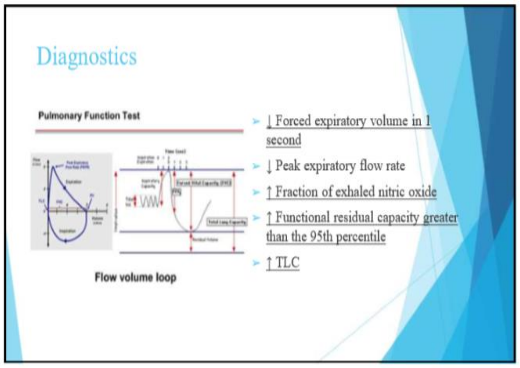
10


The Physiological Effects of Asthma
Asthma
Decreased upper airway patency
Lung compliance changes
Bronchial hyperresponsiveness
Irreversible airflow obstruction

11


Continued
Normal bronchial tube
Relaxed smooth muscles
Alveoli
Inflamed bronchial tube of an asthmatic
Tightened smooth muscles
Swelling
Mucus
Chronic lung disease, with chronic inflammation
Mast cell release of mediators
Leads to bronchospasm, mucous secretion, and reflex coughing
Due to different origins

12

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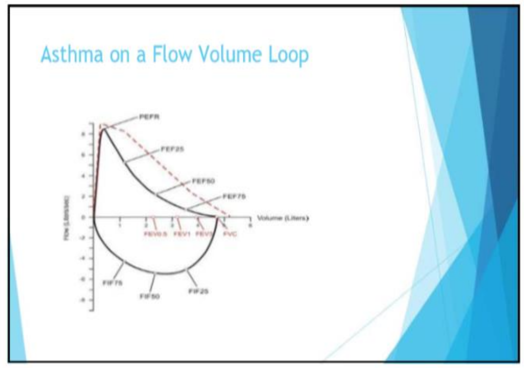


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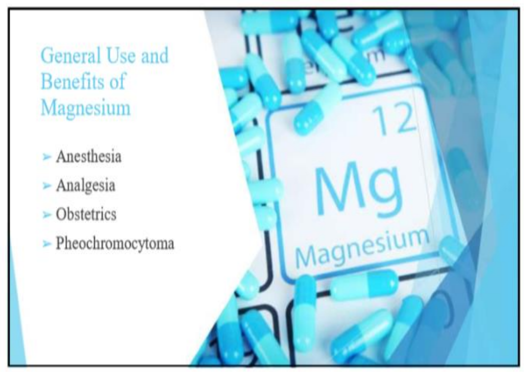


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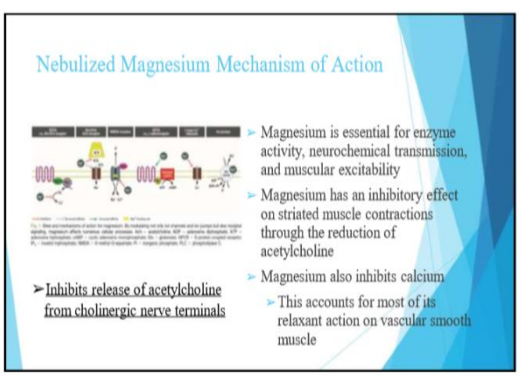


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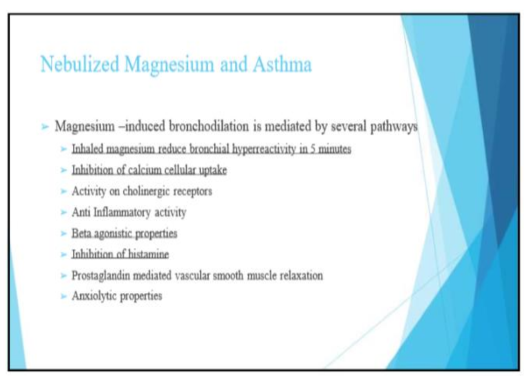


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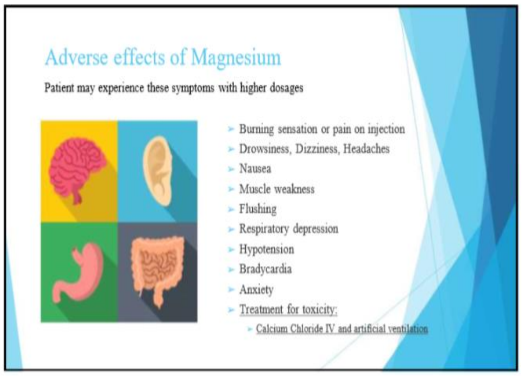


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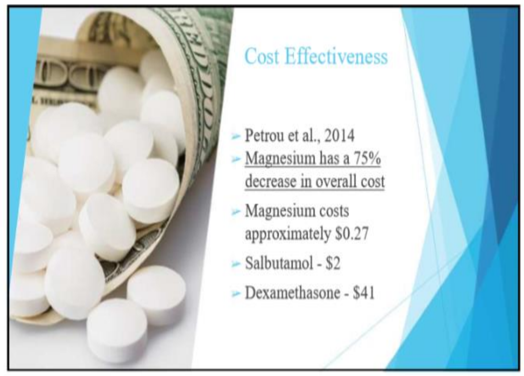


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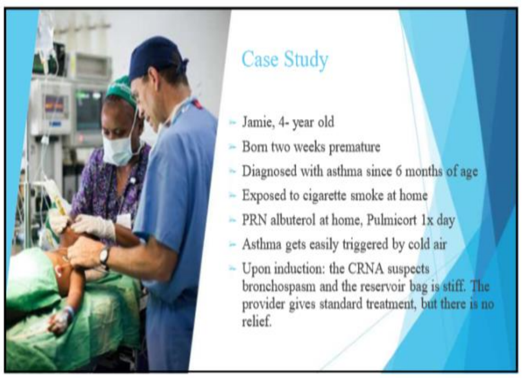


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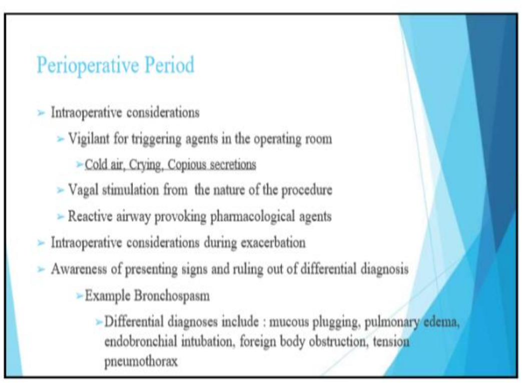


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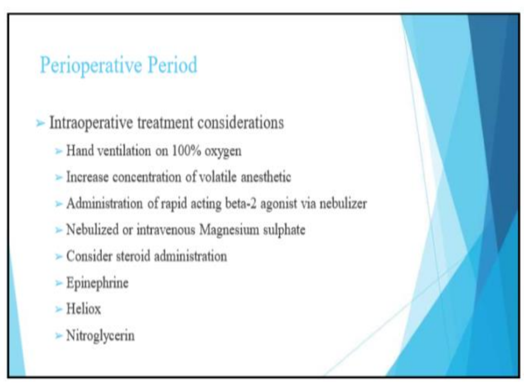


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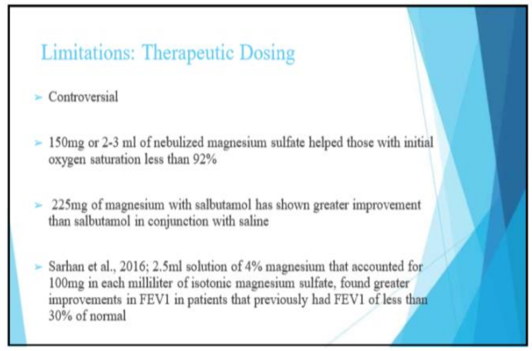


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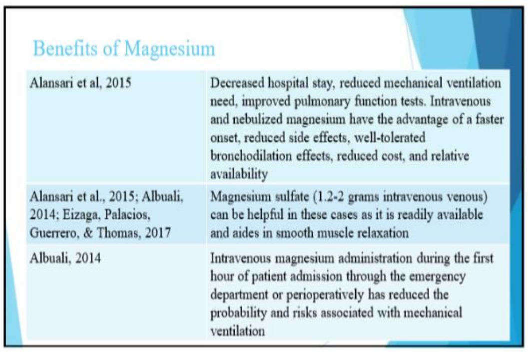


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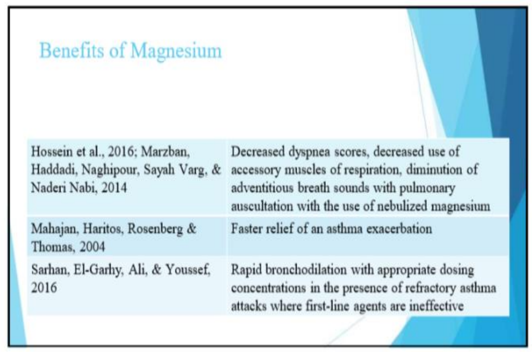


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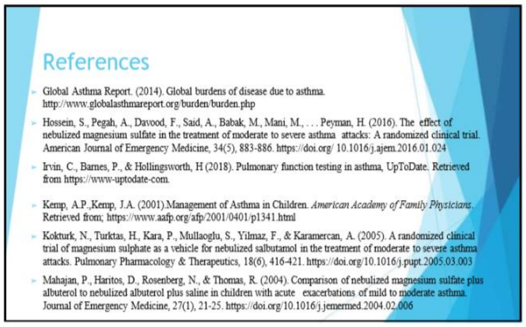
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31


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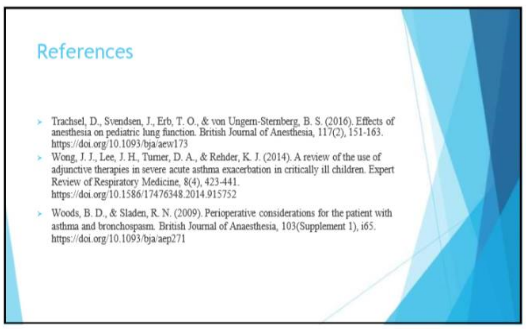
32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Trachsel, D., Svendsen, J., Erb, T. O., & von Ungern-Sternberg, B. S. (2016). Effects of anesthesia on pediatric lung function. British Journal of Anesthesia, 117(2), 151-163. https://doi.org/10.1093/bja/aew173
Wong, J. J., Lee, J. H., Turner, D. A., & Rehder, K. J. (2014). A review of the use of adjunctive therapies in severe acute asthma exacerbation in critically ill children. Expert Review of Respiratory Medicine, 8(4), 423-441. https://doi.org/10.1586/17476348.2014.915752
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33

**Appendix E**

| | Pre-Test Scores | Pre-Test Grade Percentages | Post-Test Scores | Post-Test Grade Percentages |
|---|---|---|---|---|
| **Test 1** | 5/10. | 50% | 8/10. | 80% |
| **Test 2** | 6/10. | 60% | 7/10. | 70% |
| **Test 3** | 2/10. | 20% | 6/10. | 60% |
| **Test 4** | 4/10. | 40% | 6/10. | 60% |
| **Test 5** | 2/10. | 20% | 7/10. | 70% |
| **Test 6** | 3/10. | 30% | 5/10. | 50% |
| **Test 7** | 5/10. | 50% | 7/10. | 70% |
| **Test 8** | 6/10. | 60% | 9/10. | 90% |
| **Test 9** | 5/10. | 50% | 6/10. | 60% |
| **Test 10** | 6/10. | 60% | 6/10. | 60% |
| **Test 11** | 2/10. | 20% | 7/10. | 70% |
| **Test 12** | 6/10. | 60% | 8/10. | 80% |
| **Test 13** | 6/10. | 60% | 7/10. | 70% |
| **Test 14** | 2/10. | 20% | 7/10. | 70% |
| **Test 15** | 5/10. | 50% | 9/10. | 90% |
| **Test 16** | 6/10. | 60% | 8/10. | 80% |
| **Test 17** | 3/10. | 30% | 8/10. | 80% |
| **Test 18** | 7/10. | 70% | 7/10. | 70% |
| **Test 19** | 1/10. | 10% | 7/10. | 70% |
| **Test 20** | 4/10. | 40% | 7/10. | 70% |
| **Test 21** | 1/10. | 10% | 7/10. | 70% |
| **Average Percent** | | 41.43% | | 70.95% |

**Paired Samples Statistics**

| | | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Pair 1 | Pre-Test | .4143 | 21 | .19049 | .04157 |
| | Post-Test | .7095 | 21 | .09952 | .02172 |

**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 | Pre-Test - Post-Test | -.29524 | .18835 | .04110 | -.38097 | -.20950 | -7.183 | 20 | .000 |