PERIOPERATIVE CORNEAL ABRASION: AN EXPLORATION OF EDUCATIONAL INTERVENTION EFFECTIVENESS AND IMPACT ON PREVENTION PRACTICES

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By

Aaron R. Gonzalez-Birr, B.S.N.

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Aaron R. Gonzalez-Birr, B.S.N.

Scholarly Project Advisor: Ladan Eshkevari, Ph.D.

ABSTRACT

Research has identified risk factors associated with the development of perioperative corneal abrasions.[2-4] Evidence suggests preventative measures that can be utilized to prevent corneal abrasions, however a standardized perioperative corneal abrasion prevention guideline has not been developed by any professional anesthesia organization.[8,9,10-12] Due to the lack of standardized guidelines, individual institutions are left to develop their own perioperative corneal abrasion prevention guidelines, the effectiveness of which are largely unknown. The primary purpose of this study is to determine anesthesia providers' current level of understanding of perioperative corneal abrasion prevention practices. The secondary purpose is to determine what impact an educational in-service has on the anesthesia provider's understanding of perioperative corneal abrasion prevention practices.

This study was conducted using a quantitative quasi-experimental pre-post interventional design. The design for this research was used to evaluate anesthesia provider's understanding of perioperative corneal abrasion prevention methods before and after an educational in-service and the impact the intervention may have on their practices. The non-randomized convenience sample for this study included Anesthesiologists (MDAs) and Certified Registered Nurse Anesthetists (CRNAs) who practice in two mid-Atlantic teaching hospitals in the United States. The de novo data collection tool utilized for this study included a pre-test and identical post-test administered approximately one month after the educational intervention. The pre and post-test

consisted of 15 identical questions in 3 parts consisting of demographics, prevention practices, and 5-point Likert scale questions regarding the provider's willingness to alter current practices.

Participants demonstrated a basic understanding of perioperative corneal abrasion prevention methods. The educational intervention did not have a significant association with improved understanding of perioperative corneal abrasion prevention understanding ($p = 0.171$) or a significant impact on anesthesia providers' prevention methods ($p = 0.213$-0.277) however post-test scores did improve from 76% to 82%. Furthermore, 80% of participants felt that an educational intervention would have a significant impact on their corneal abrasion prevention methods. Continued perioperative corneal abrasion prevention education is warranted as the benefits of reduced corneal abrasions, including improved patient comfort, patient satisfaction, and reduced cost to the patient outweigh the cost of an educational in-service.

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CHAPTER 1

Introduction

The World Health Organization has estimated that 312.8 million surgical operations were performed in 2012 with surgical volume continuing to increase.[1] The rate of perioperative ocular injury for nonocular surgery is between 0.02% to 0.11%.[2-4] While the incidence of this complication is low, the American Society of Anesthesiologists has determined that 3% of all malpractice claims are related to eye injuries, 35% of which are due to corneal abrasions.[5] Furthermore, perioperative corneal abrasions affect a patient's comfort, ability to return to work, and financial cost.[6-7]

Problem Statement

Research has identified risk factors associated with the development of perioperative corneal abrasions.[2-4] Evidence suggests preventative measures that can be utilized to prevent corneal abrasions, however a standardized perioperative corneal abrasion prevention guideline has not been developed by any professional anesthesia organization.[8,9,10-12] Due to the lack of standardized guidelines, individual institutions are left to develop their own perioperative corneal abrasion prevention guidelines, the effectiveness of which are largely unknown.

Purpose of Study

The primary purpose of this study is to determine anesthesia providers' current level of understanding of perioperative corneal abrasion prevention practices. The secondary purpose is to determine what impact an educational in-service has on the anesthesia provider's understanding of perioperative corneal abrasion prevention practices.

Research Questions

The research questions for this study are:

1. What is the anesthesia provider's level of understanding of perioperative corneal abrasion prevention practices?
2. Does an educational intervention impact the anesthesia provider's understanding of perioperative corneal abrasion prevention practices?
3. Does an educational intervention impact anesthesia providers' current perioperative corneal abrasion prevention practices?

Definitions

For the purpose of this study, the following terms and definitions will be used.

Conceptual/Theoretical Definitions

1. Understanding: level of competency of a subject.
2. Perioperative corneal abrasion prevention practice recommendations: evidence-based methods used by anesthesia providers to prevent trauma to the cornea during the perioperative period.
3. Educational intervention: material used to increase competency of a subject.

Operational Definitions

1. Understanding: a pre/post knowledge written test consisting of 15 questions in ten minutes.
2. Perioperative corneal abrasion prevention practices: Evidence-based methods as well as methods listed on the employer's clinical advisory message.
3. Educational intervention: a 15 minute in-person educational in-service consisting of a PowerPoint presentation.

CHAPTER 2

Review of Literature

This chapter will begin with a review of the pathophysiology and risk factors of corneal abrasions. Next, current techniques to prevent corneal abrasions will be discussed. The evidence of these risk factors and preventative techniques aide in developing the hospital based perioperative corneal abrasion prevention policy. Finally, current evidence regarding perioperative corneal abrasion policy efficacy will be reviewed and gaps in the literature identified.

Pathophysiology and Risk Factors

The cornea is the outermost layer of tissue of the human eye.[13] Consisting of avascular connective tissue, the cornea provides the primary structural and infectious barrier for the eye.[13] A corneal abrasion is a scratch or cut on the corneal epithelium, the outermost layer of the cornea.[13] Corneal abrasions result from physical trauma, exposure keratopathy, or reduced tear production.[11] Physical trauma can result from mechanical sources such as fingers and medical devices or chemical sources such as antimicrobial solutions and halothane inhalation.[11] Exposure keratopathy is damage to the cornea resulting from the inability to completely close the eyelid.[11] Reduced tear production contributes to corneal dehydration and increased risk of erosion.[11]

There are numerous anatomical and physiological mechanisms in place to protect the cornea, all of which can be directly affected by anesthetic administration. When noxious stimuli are present, reflex tearing causes lacrimal glands, conjunctiva, and corneal epithelium to secrete aqueous and mucous components of tears.[8] Basal tear production is severely reduced during the administration of general anesthesia.[14] The lipid component of tears is passively released on contraction of pretarsal orbicularis oculi fibers during blinking.[8] These components minimize friction and dryness of the corneal surface, aides in corneal oxygenation, and acts as a barrier from microbes.[8] The blinking reflex is abolished while a patient receives general anesthesia.[8] Eyelid closure is another form of protection for the cornea and contraction of the orbicularis oculi maintains closure during normal sleep.[8] Lagophthalmos, the inability to completely close the eyelids, results in the cornea drying out and increased risk of exposure keratopathy.[8] Bell phenomenon is the reflexive upward movement of the front of the eyeball when the eyelids close or blink.[8] This is a natural form of protection for the cornea during sleep.[8] Patients who receive general anesthesia exhibit lagophthalmos and a significantly reduced Bell's phenomenon.[8]

Considerable research has been conducted to determine the prevalence of corneal abrasions in non-ocular surgical patients and attributable risk factors. A retrospective review by Roth et al. examined 60,965 patient records between 1988 to 1992 and determined that the overall incidence of eye injury for nonocular surgery was 0.056% with corneal abrasions comprising 61.7% of these injuries.[2] Other injuries included conjunctivitis, blurred vision persisting longer than one day, chemical injury, permanent vision loss, and eyelid hematoma.[2] Compared with the patients without eye injuries, patients with eye injuries were older (51.2 +/- 16.6 years vs. 44.1 +/- 20.7 years; P = 0.017) and underwent lengthier procedures under general anesthesia (4.7 +/- 3.0 hours vs. 2.9 +/- 2.6 hours; P = 0.001 by t test).[2] The authors did not

explain the significant overlap between ages, however the large sample size might play a role.[2] This review concluded that length of procedure played a more significant role than age in perioperative corneal abrasion risk.[2] Inpatients were more likely to sustain an eye injury than outpatients with an odds ratio of 10 and operations performed on Monday demonstrated an increased risk of eye injury compared to other days of the week with an odds ratio of 2.5.[2] The authors were unable to explain this finding but proposed reviewing other more common injuries such as dental damage to determine a consistent pattern with ocular injury.[2] Use of general anesthesia was an independent risk factor and used in 97% of cases involving eye injury.[2] Eye injuries occurred more often with tracheal intubation compared to mask ventilation with an odds ratio of 3, however this reflects the association of endotracheal intubation with general anesthesia.[2] When controlled for general anesthesia, risk of eye injury in patients receiving general anesthesia did not increase with endotracheal intubation ($P = 0.88$).[2] Surgeries involving the head or neck were 4.4 times more likely to sustain an eye injury.[2] Finally, incidence of eye injury was greater with patients in the lateral position during surgery with an odds ratio of 4.7.[2] The direct cause of injury was determined in 21% patients with corneal abrasions, two involved accidental loosening of tape covering the eye, one involved iodine prep solution dripping into the eye, and one involved an intravenous pole falling onto the patient's face.[2] The authors identified difficulty in following up with outpatient individuals included in the study as the most probable source error.[2]

A study by Yu, Yang, and Chang between 2006 and 2008 reviewed the incidence of overall perioperative eye injury in 75,120 patients and reported an incidence of 0.023% with 58.8% of these injuries consisting of corneal abrasions.[3] Other injuries included conjunctivitis,

prolonged blurred vision and blindness.[3] Older patients were more susceptible to eye injuries (50.8 +/- 15.9 years vs. 45.4 +/- 20.6 years; P = 0.251) and subjected to longer procedures (4.34 +/- 1.65 hours vs. 3.34 +/- 2.06 hours; P = 0.002).[3] Similar to the previous study, length of procedure appears to be a more significant risk factor than age.[2,3] 41.2% of the eye injuries studied involved head and neck surgeries.[3] The authors attributed this to the inability to tape eyes during these procedures due to proximity of the surgical field, inadvertent instillation of antimicrobial preparation, direct trauma by surgical or anesthesia tools as well as miscellaneous articles such as watches, stethoscopes, and identification badges.[3] This study included perioperative anemia as well as intraoperative deliberate hypotension as significant risk factors for eye injury during nonocular surgeries.[3] The authors were unable to determine the mechanism for eye injury due to anemia and recognized the need for further evaluation.[3] Five of the eye injuries presented with anemia preoperatively.[3] The authors did not specify what form of eye injury these specific patients sustained.[3] The two primary types of eye injuries included in this study were corneal abrasion and conjunctivitis.[3] Deliberate hypotension can be used to limit intraoperative bleeding, however the cornea is very sensitive to hypoxia and deliberate hypotension can cause hypoperfusion of ocular tissues.[3] Finally, 11.8% of patients with an eye injury were involved in surgeries requiring lateral positioning.[3] Possible causes of injury included direct compression of the orbit, direct injury to the eyes during positioning, and increased intracranial pressure secondary to decreased venous return from the head.[3] The most significant limiting factor of this review was the author's omission of short outpatient procedures in the patient population.[3]

From 2007 to 2008, a retrospective review of 78,542 surgical cases was conducted with a corneal abrasion incidence of 0.11%.[4] The authors did not indicate if these cases took place at one or multiple surgical sites.[4] This study analyzed data differently from the previous two studies by using a computer generated sample to randomly select a cohort of controls.[4] The rational was to allow for statistical assessment of a wide range of risk factors for corneal abrasions.[4] The controls were not matched to the corneal abrasion group by age, date, time, or anesthesia team to further enhance the significance of comparisons.[4] The average age of patients with a corneal abrasion was higher (55 years vs. 45 years; $P = 0.0036$) and operative times were longer (3.85 vs. 1.7 hours; $P < 0.001$).[4] This was the only study reviewed that found increased age as a significant risk factor.[4] Patients who received general anesthesia were at an increased risk of corneal abrasions (95% vs. 47%; $P < 0.001$).[4] This study did not analyze the effects of lateral positioning on corneal abrasion rates but concluded that Trendelenburg positions is a significant risk factor (26% vs. 6%; $P < 0.001$).[4] The authors attribute this to increased corneal thickness due to elevated intravascular, episcleral venous, and intraocular pressure.[4] The study claims that the prone position results in an increased risk of corneal abrasions but failed to include prone patients in the control group.[4] Patients who received supplemental oxygen en route to the recovery unit had an increased risk of corneal abrasions (69% vs. 24%; $P <0.001$) and different forms of oxygen delivery did not significantly differ between the corneal abrasion group and the control group.[4] The authors did not give an explanation for this finding but mechanical trauma from the oxygen delivery device might play a role.[4] Greater estimated blood loss was more prevalent in the corneal abrasion group (191 ml vs. 90 ml; $P < 0.001$).[4] An increased risk for corneal abrasions was found in same day admissions in the main recovery unit compared to ambulatory or other recovery sites (66% vs. 27%; $P < 0.004$).[4] Finally, patients

who had their eyes taped compared to no tape during the procedure had an increased risk of corneal abrasions (94% vs. 52%; $P < 0.001$).[4] The authors postulated rough application or removal of the tape and the patient inadvertently rubbing their eyes as a possible explanation.[4] The authors did not explain further why the control group had so few patients without taped eyes and if there is a relation between the tape variable and other variables in the study such as type of anesthesia, surgery time, and patient positioning.[4] This is the only study reviewed that listed taped eyes as a risk factor for corneal abrasions and this is contradictory to all other data available.[2-4] Overall, the rationale for using a control group was not fully explained and analyzing the entire sample size of 78,542 procedures could have filled the gaps left by the control group.[4]

Wan et al. performed a prospective study comparing hydro-gel eye patches to adhesive tape in prevention of perioperative corneal abrasions as well as eye discomfort and skin irritation.[15] Seventy-six patients undergoing general anesthesia were included in this study.[15] Each patient had a hydro-gel patch applied to one closed eyelid and adhesive tape applied to the opposite closed eyelid by random computer generated allocation.[15] Handheld slit lamp testing with fluorescent dye was used directly after each surgical procedure.[15] Out of the seventy-six patients enrolled in the study, 15.8% of patient with hydro-gel patches and 39.5% of patients with tape demonstrated ocular injury.[15] This is a significantly higher rate of injury compared to all previous studies.[2-4,15] The researchers contribute this to the use of a handheld slit lamp test in diagnosing the corneal abrasion.[15] This study differs from the previous reviews due to being prospective rather than retrospective.[15] Furthermore, none of the retrospective studies described

how the corneal abrasions were diagnosed.[2-4] This implies the possibility of underestimating perioperative corneal abrasion rates due to lack of symptoms and routine testing.

There is a trend among literature reviewing perioperative corneal abrasion risk factors. Longer procedures, positions other than supine, and procedures that take place near the face and eyes are significant risk factors.[2-4] Older patients were identified as a risk factor, however this population undergoes more procedures requiring general anesthesia and the significance of this variable is in question.[2-4] Two studies concluded that oxygen delivery device use during transit to the recovery unit was a risk factor.[3,4] All of these variables have the potential to cause corneal abrasions through mechanical trauma.[2-4] One review concluded that anemia as well as deliberate perioperative hypotension were comorbidities that increased the risk of corneal abrasions.[3] These variables have the potential to reduce corneal structural integrity and increase the risk of damage.[3] The common limiting factor for most of the studies reviewed was the retrospective method utilized as well as lack of diagnostic techniques.[2-4] Due to the small number of perioperative corneal abrasion incidences, it is very difficult to conduct prospective studies for this subject. However, Wan et al. demonstrated the possibility of underestimating corneal abrasion incidences and further research is warranted.[15]

Perioperative Corneal Abrasion Prevention Techniques

Batra and Bali studied 200 healthy adult patients undergoing general anesthesia, 100 of which did not have tape or gauze applied to the eyes.[10] Fifty nine individuals in the unprotected group exhibited partial opening of the eyelids and 44% of these patients developed corneal

abrasions.[10] None of the protected patients exhibited signs of corneal abrasions.[10] Proper application of adhesive tape in a horizontal fashion after induction and prior to intubation prevents lagophthalmos, exposure keratopathy, as well as chemical injury.[11,16]

In 2013, Grixti et al. reviewed eight randomized control trials to determine the efficacy of perioperative corneal protection techniques.[11] This study determined that there was no significant reduction of corneal abrasion rates with ocular lubricants with or without tape over the eyelids compared to tape alone.[11] Furthermore, there was no significant difference between aqueous solutions or paraffin-based ointments in preventing corneal abrasions.[11] Paraffin-based ointments pose an increased risk of blurred vision, local allergic reactions, photophobia, and foreign body sensation.[11,17] Halothane is thirty-five times more soluble in paraffin ointment than aqueous solutions, resulting in ocular inflammation.[11] Due to these risks, paraffin-based ointments are not recommended in current corneal abrasion prevention techniques.[8,11] Paraffin-based ointments remain in the eye longer than aqueous solutions (32 minutes vs. 12 minutes).[11] This finding indicates the need to repeatedly instill aqueous solutions during an extended procedure.[11] There is a lack of literature investigating the benefits and risks of reapplying ocular lubricants during a surgical procedure. An assumption can be made that repeatedly removing tape, opening the eye and replacing tape during surgery could increase the risk of an abrasion.

Previously, multiple studies conclude that tape over the eyelid is sufficient, however the use of transparent bio-occlusive dressings and hydro-gel eye patches can be used in place of adhesive tape.[11,12,15,18] Bio-occlusive dressings provide a tight seal completely around the eye and aid in maintaining moisture on the corneal surface.[11] Lavery et al. studied the efficacy of

sterile, transparent occlusive dressings in patients undergoing robotic prostatectomies in a single institution by a single surgeon from 2007 to 2009.[12] The first 214 patients did not have a dressing applied, 2.3% of which developed corneal abrasions.[12] The remaining 814 patients had occlusive dressings applied with zero corneal abrasion complications (P = < 0.001).[12] Wan et al. concluded that hydro-gel eye patches reduced perioperative corneal abrasions rates without a significant reduction in skin irritation or blurred vision compared to adhesive tape.[15] The authors contributed this to the unique polymer materials used in hydro-gel in maintaining ocular hydration and protection.[15] Conflicting studies exist suggesting the efficacy of tape, bio-occlusive dressings, and hydro-gel eye patches in reducing the risk of perioperative corneal abrasions.[11,12,15,18] Additional studies are warranted to determine conclusive evidence of a superior technique.

Corneal Abrasion Prevention Policy Efficacy

Individual risk factors and methods to reduce the incidence of perioperative corneal abrasions have been identified.[2-4] Literature has been published describing recommendations institutions can use to develop hospital-based prevention policies.[8,10-12,15-18] However, there is a lack of published literature regarding the short and long-term efficacy of these hospital-based perioperative corneal abrasion prevention policies. One study was identified that implemented known methods to reduce corneal abrasion rates in a hospital-based setting.[9]

Martin et al. conducted a two-part performance improvement program to reduce corneal abrasion rates.[9] The first phase involved an electronic notification to all personnel involved in a

surgical case upon diagnosis of a corneal injury by an ophthalmologist.[9] The purpose of this phase was to increase awareness of the injury.[9] The second phase was a 45-minute educational lecture given separately to the anesthesiologists as well as CRNAs and SRNAs.[9] This lecture included risk factors, corneal abrasion symptom identification, and methods to reduce the rate of injuries, including taping of the eyes.[9] Martin et al. observed a significant reduction in corneal abrasion incidences after the educational phase was performed (1.51 per 1,000 surgeries to 0.47 per 1,000 surgeries).[9] This study concludes that a structured educational component to perioperative corneal abrasion prevention, in addition to a hospital-based policy, has the potential to significantly reduce the incidence of injury.[9]

Summary

Corneal abrasions represent the most common form of eye injury in patients receiving general anesthesia.[2-5,9] Multiple studies have determined possible risk factors for perioperative corneal abrasions related to mechanical trauma structural weakening.[2-4] These risk factors include longer procedures, positions other than supine, procedures that take place near the face and eyes, anemia, and deliberate hypotension. All research pertaining to risk factors were retrospective in nature with associated limitations.

Research identified adhesive tape as a sufficient measure to protect patient's eyes from mechanical trauma during the perioperative period. [8,10-12,15-18] Additional research is warranted comparing the advantages and downsides to adhesive tape, bio-occlusive dressings, and hydro-gel eye patches in preventing corneal abrasions. [11,12,15,18] More recently, promising data has

emerged regarding the use of hydro-gel in protecting the eyes from mechanical trauma as well as retaining hydration.[15]

Identifying perioperative corneal abrasion risk factors and prevention methods aides in the development of a hospital-based prevention policy. Literature is limited regarding the efficacy of these policies. Martin et al. demonstrated positive outcomes from a structured educational intervention upon diagnosis of a corneal abrasion.[9] However, the short and long-term effects of hospital-based policies without these educational components is lacking.

CHAPTER 3

Methodology

This chapter presents the methodology that was used to answer the following research questions: (1) What is the anesthesia providers' level of understanding of perioperative corneal abrasion prevention practices? (2) Does an educational intervention impact the anesthesia providers' understanding of perioperative corneal abrasion prevention practices? (3) Does an educational intervention impact anesthesia providers' current perioperative corneal abrasion prevention practices? Additionally, this chapter outlines the research design, sample, instrumentation, procedure, data analysis, and protection of human subjects.

Research Design

This study was conducted using a quantitative quasi-experimental pre-post interventional design. The design for this research was used to evaluate anesthesia provider's understanding of perioperative corneal abrasion prevention methods before and after an educational in-service and the impact the intervention may have on their practices.

Sample

The non-randomized convenience sample for this study included Anesthesiologists (MDAs) and Certified Registered Nurse Anesthetists (CRNAs) who practice in two mid-Atlantic teaching hospitals in the United States. Permission to conduct the study was obtained by

contacting the Chairman of Anesthesiology by email requesting participation of his department. (See Appendix A). Inclusion criteria for this study included currently practicing physicians who are certified through the American Board of Anesthesiology and currently practicing Certified Registered Nurse Anesthetists (CRNA) certified through the National Board of Certification and Recertification for Nurse Anesthetists. The exclusion criteria included medical fellows, residents, interns, and student registered nurse anesthetists.

According to the Bureau of Labor Statistics, as of May 2016 there are approximately 30,190 currently employed MDAs and 39,860 currently employed CRNAs.[19, 20] By using the sample size calculator provided by Raosoft, Inc (Appendix A), a sample size of 68 participants from a population size of 70,050 will yield a margin of error of 10% and confidence level of 90% (See Appendix A). The sample size for this study included a total of 40 anesthesia providers.

Instrumentation

The de novo data collection tool utilized for this study included a pre-test and identical post-test after the educational intervention (see Appendix A). The pre and post-test consisted of 15 identical questions in 3 parts. The first part contained five demographic questions, including profession, gender, age, years of experience, and hours of work each week. This knowledge gave the researcher the ability to correlate demographic data to perioperative corneal abrasion prevention practice understanding and willingness to alter practices. The second part contained nine multiple choice questions regarding perioperative corneal abrasion prevention practices.

These questions covered etiologic factors, use of ophthalmic lubricants, eye tape, monitoring devices, approaches to perioperative corneal abrasion management, aspects of perioperative corneal abrasion management, ophthalmology consultation, and documentation. The third part contained five questions in the form of a Likert scale regarding the provider's willingness to alter current practices.

Five experts reviewed the data collection pre-post tool for content validity. The first expert holds a PhD in Physiology and Biophysics and is a professor in the graduate Nurse Anesthesia Program in Georgetown University. The second expert holds a PhD in technology policy and management and is an assistant professor. The third expert is a board-certified Anesthesiologist and holds a Master of Public Health. The fourth and fifth experts include a Board-Certified Anesthesiologist and CRNA respectively.

Procedure

Upon approval from the Georgetown University Institutional Review Board, the Chiefs of the Department of Anesthesia at the two mid-Atlantic hospitals were contacted to schedule a date for the administration of the pre-test and educational in-service in the anesthesia conference room as well as a date one month later for the administration of the post-test. At this time the informed consent was forwarded to the chiefs of anesthesia to be emailed to their respective MDAs and CRNAs for review. Upon meeting in the conference room, the same informed consent was provided in paper form to the potential participants and time was given to review potential questions and obtain consent. The pre-test was then administered, and the participants

were provided approximately 10 minutes for completion. After the pre-tests were completed and collected by the principle investigator, the educational in-service began and took approximately 15 minutes to complete. The in-service consisted of a Powerpoint presentation covering etiologic factors, use of ophthalmic lubricants, eye tape, monitoring devices, approaches to perioperative corneal abrasion management, aspects of perioperative corneal abrasion management, ophthalmology consultation, and documentation. (Appendix A) Upon completion of the pre-test and in-service, the paper copies of the informed consent and pre-test were stored in a locked box in the principle investigator's office, scanned into a secure Google Drive within 24 hours and promptly shredded.

The principle investigator returned approximately one month after the pre-test to the anesthesia conference rooms of the respective hospitals to administer the post-test. Informed consent was reviewed prior to administration of the post-test to answer additional questions. The post-test took approximately 10 minutes to complete. Upon completion of the post-test, the paper copies were stored in a locked box in the principle investigator's office, scanned into a secure Google Drive and promptly shredded.

Data Analysis

After completion of the data collection using the pre and post-test, the principle investigator compiled the data into an excel spreadsheet. The spreadsheet was analyzed using R statistical programming software (v. 3.6.0). With assistance from the statistician, the principle investigator used continuous data and a Student's 2-sample t-test to analyze the participant's

understanding of perioperative corneal abrasion prevention practices. A chi squared test was used to analyze the Likert scale questions regarding the impact of the educational in-service on participant's corneal abrasion prevention practices.

Protection of Human Rights

All individuals interested in participating in the study were forwarded an electronic copy of the informed consent (Appendix A) by their respective Chief of the Department of Anesthesia upon the scheduling of dates for administration of the pre-test, educational in-service, and post-test. On the prescheduled date of administration, potential participants were provided with paper copies of the informed consent and given adequate time to review the consent and ask potential questions to the principle investigator. The consent included the purpose and procedure of the study, participant expectations, the voluntary nature of the study, methods to protect personal information, risks associated with the study, and relevant contact information. No identifiable information of the participants was recorded in this study besides participant's informed consent signatures. Participants were afforded the opportunity to withdraw from the study at any point in time.

The paper copies of the informed consent, pre-test, and post-test were stored in a locked box in the principle investigator's office. The paper copies were scanned into a secure Google Drive account and promptly be shredded. Google Drive provides two-factor authentication, TLS standard encryption and 128-bit AES decryption and re-encryption to protect against data

leakage.(safety.google.com) The electronic data was saved for 3 years per Georgetown University standards.

CHAPTER 4

Findings

Following the collection of data as explained in the previous chapter, the information was organized and calculations performed using R statistical programming software (v. 3.6.0). This chapter clarifies in detail the sample population used for this study, the practitioner's understanding of perioperative corneal abrasion prevention practices, as well as the impact of an educational intervention on practitioner's understanding of perioperative corneal abrasion prevention techniques using a Welch t test. Finally, the impact of the educational intervention on the anesthesia provider's perioperative corneal abrasion prevention practices will be demonstrated using a chi square test.

Sample

The demographic data (Graph 1) of the sample was collected using questions one through five in the Pre and Post Test. (Figure 1, Figure 2). The total sample size of this study included 40 individuals: eight Anesthesiologists, and 32 CRNAs. Female participants made up 65% of the sample. The majority of participants were aged 30-39 years of age, 37.5% of the Anesthesiologists and 56.3% of the CRNAs, followed by 12.5% of the Anesthesiologists and 31.3% of the CRNAs who were 40-49 years old. The remaining participants were 50 to 59 years old.

Most of the Anesthesiologists (50%) included in this study have practiced for over 15 years. 25% of the Anesthesiologists had been in practice for 1 to 5 years, and 6 to 10 years respectively. No Anesthesiologists in this study practiced between 10 and 15 years.

The majority of CRNAs included in this study (53.1%) have practiced anesthesia for one to five years. 15.6% of the CRNAs have practiced for 6 to 10 years and 10 to 15 years. 9.4% of CRNAs in this study have practiced for more than 15 years and the remaining 6.3% have less than one year of experience.

Most Anesthesiologists and CRNAs in this study are in the clinical setting for 40 to 60 hours a week, 87.5% and 59.4% respectively. 12.5% of Anesthesiologists and 21.9% of CRNAs in the sample work less 25 to 40 hours a week. Only 3.1% of CRNAs in this study work less than 24 hours a week.

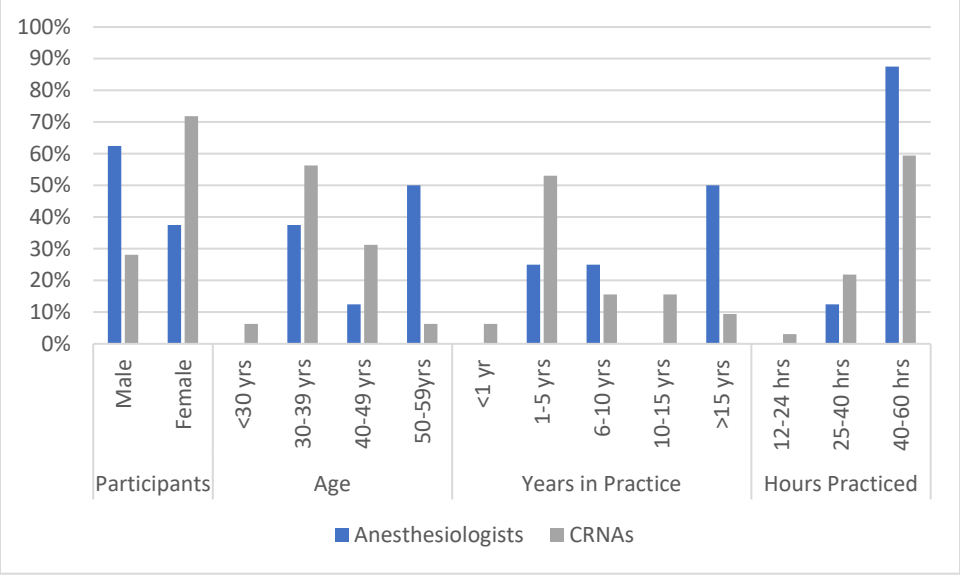


Figure 1: Demographic Data

Research Question 1

What is the anesthesia provider's level of understanding of perioperative corneal abrasion prevention practices? Part two of the Pre-test (Appendix A) was utilized to assess the participant's understanding. The results of the Pre-test (Graph 2) demonstrated a mean score of 76% between both Anesthesiologists and CRNAs with a standard deviation of 0.118. The mean score and standard deviation of Anesthesiologists was 77.8% and 0.785 respectively. The CRNAs demonstrated a mean score and standard deviation of 75.6% and 0.128 respectively.

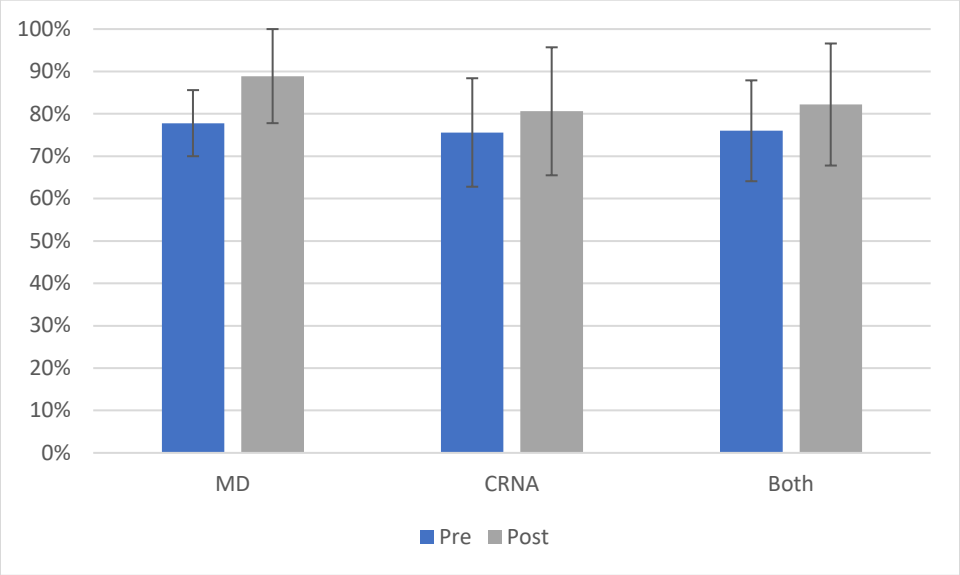


Figure 2: Pre/Post Test Mean and SD

Research Question 2

Does an educational intervention impact the anesthesia provider's understanding of perioperative corneal abrasion prevention practices? The Post-test was administered one month following the educational intervention. The results of the post-test (Graph 2, Graph 3)

demonstrated a mean score of 82.2% and a standard deviation of 0.144 between both Anesthesiologists and CRNAs. The Welch Two Sample t-test was utilized to compare the Pre and Post-test data collected for this study. The t-test results demonstrated a *p*-value of 0.1711.

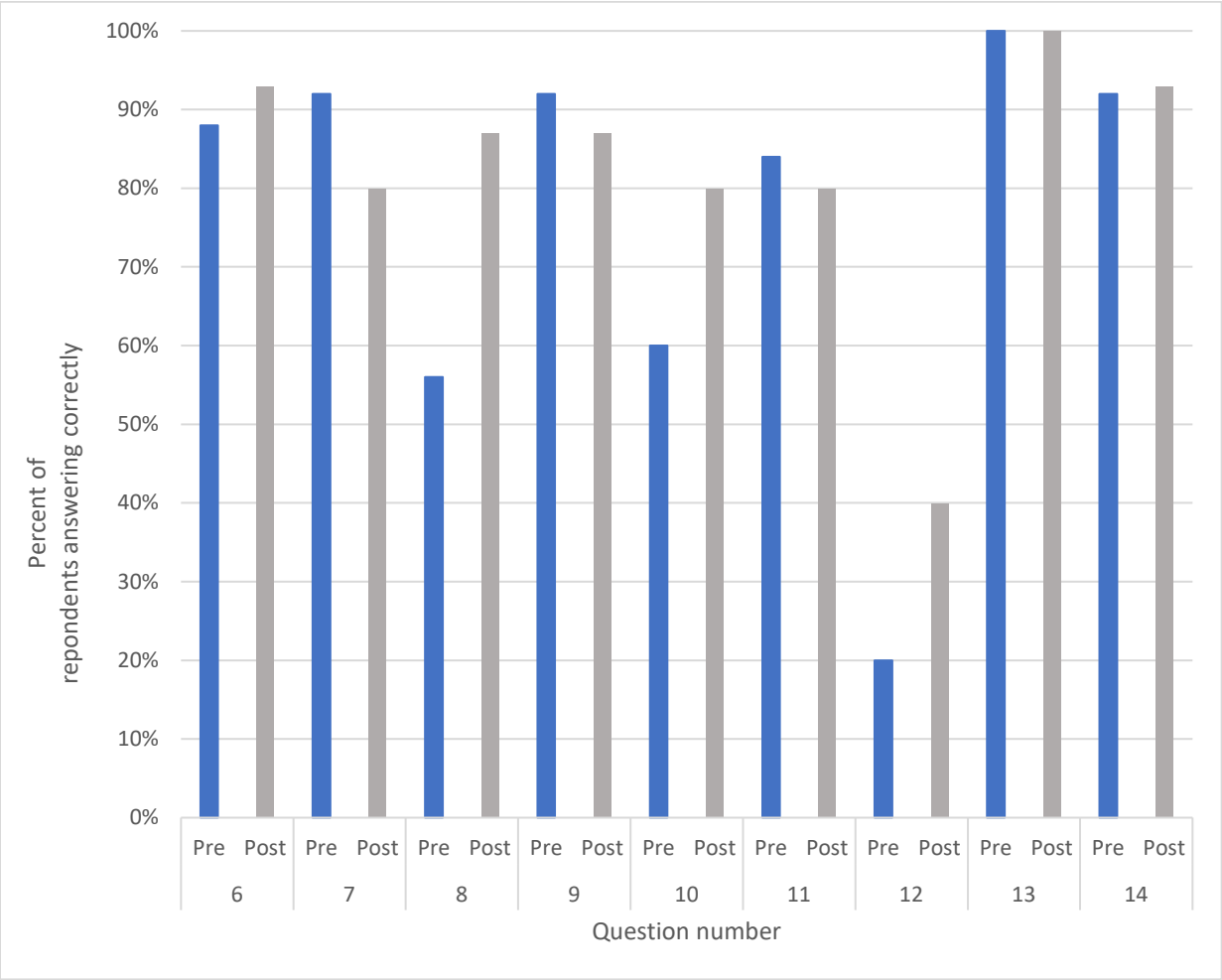


Figure 3: Pre/Post Test Part Two

Research Question 3

The final question was designed to identify the impact an educational intervention would have on anesthesia provider's perioperative corneal abrasion prevention practices. This data (Graph 5) was collected using part three in the pre- and post- test with questions in the form of a

five-point Likert scale. The data from questions 15 through 19 were analyzed using a chi square test with *p* values of 0.213, 0.241, 0.277, 0.22, and 0.213 respectively.

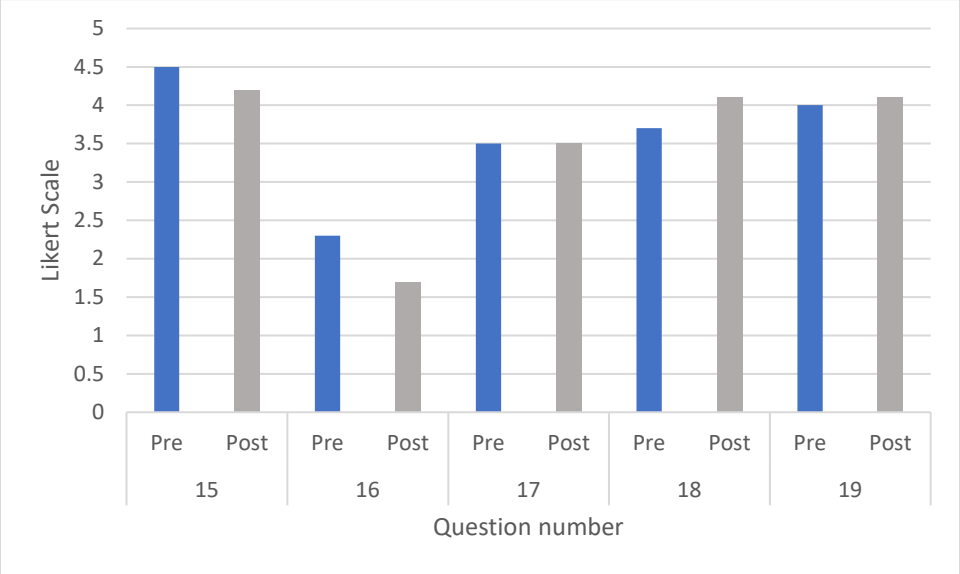


Figure 4: Pre/Post Test Part Three

Summary

In total, 40 anesthesia providers participated in this study with the majority being CRNAs in their 30s, with one to five years of anesthesia experience, and working at least 40 hours a week. The corneal abrasion prevention pre-test demonstrated a mean score of 76% and standard deviation of 0.144. One month after receiving the educational intervention, the post-test data revealed a mean score of 82.2% and standard deviation of 0.144. The Welch t test results showed a *p* value of 0.171 and the null hypothesis was not rejected. Finally, the results of the chi square test on the impact of an educational intervention on anesthesia providers' perioperative corneal abrasion prevention practices demonstrated a *p* value of between 0.22 and 0.277

CHAPTER 5

Discussion

This study is novel in that there are no previous studies that specifically focused on anesthesia providers' understanding of perioperative corneal abrasion prevention before and after an educational intervention; as well as the impact of an educational intervention on the providers' willingness to change their practice. A recent study analyzed a perioperative corneal abrasion performance improvement initiative that included a structured educational intervention for anesthesia providers.[9] However, this study was different in design than our study in that the researchers collected data on perioperative corneal abrasion *incidences* rather than our study, which focused on anesthesia providers' understanding of the topic. It is important to understand the efficacy of in-person educational interventions regarding perioperative corneal abrasion prevention, or if anesthesia providers' understanding is enough to maintain the currently low incidences of perioperative corneal abrasions.

The time frame between the educational intervention and post-test is supported by current evidence of knowledge retention rates.[26] The classic forgetting curve developed by Ebbinghaus theorized the level of forgotten material after a one-hour lecture over intervals ranging from 20 minutes to 31 days.[24-25] This classic experiment, replicated in 2015, demonstrated a correlation between retention and time-since-learning.[26] Without reinforcement the average learner forgets about 90% of the information presented to them within 31 days. Given the clinical nature of this

topic, the anesthesia providers were repeatedly presented with opportunities for reinforcement simply by providing general anesthesia.

Studies have determined that etiologic factors associated with perioperative corneal abrasions include impaired tear production, chemical injury, incomplete eyelid closure during surgery, and direct trauma.[2-4,9] The etiology of perioperative corneal abrasions was covered in question six of the tests. In our study, 88% of participants answered this question correctly, increasing to 93% after the educational intervention. By understanding how corneal abrasions occur, we anticipate anesthesia providers will be better equipped to prevent their occurrences.

Risk factors for perioperative corneal abrasions have been identified by several studies.[2-4,9] These include longer procedures, prone and lateral positions, procedures taking place near the face and eyes, older patients, oxygen delivery devices during transport, anemia and deliberate perioperative hypotension. Obesity was an incorrect distractor used for this question. Participants scored 92% prior to the educational intervention. Interestingly, the post test score decreased to 80%, signifying that an increased number of participants assumed obesity is a risk factor. We are unable to determine why there was a decrease in scores for this question considering the topic was explicitly covered in the educational intervention.

Studies have also determined that application of ophthalmic lubricant in addition to taping patient eyes during general anesthesia is not superior to taping the eyes alone.[11] This is a topic that was discussed extensively among the participants in both testing locations during the educational in-service, with multiple individuals having strong opinions on the matter. For

example, two participants claimed that they always use ophthalmic lubricant when administering general anesthesia. Other participants stated that they apply ophthalmic lubricant sporadically, with no consensus on when they felt this was important to do. Conversely, three participants claimed they never use lubricant on the eyes of their surgical patients and rely only on tape. Our study determined that many practicing anesthesia providers were unaware of the data supporting taping the eyes without lubricant. The educational intervention improved the participant's level of understanding, signifying the benefits of continued education regarding this subject.

Taping the eyes immediately after the loss of eyelid reflex, and prior to intubation has been recommended as a most important preventative measure to reduce perioperative corneal abrasions.[8,10-12,15,18] Most, (92%) of the participants correctly answered the appropriate time to tape the eyes of a surgical patient during the induction and intubation process. This demonstrated an excellent baseline understanding by the participants involved in this study. It is crucial that all anesthesia providers are aware of the proper time to tape the eyes of a patient receiving general anesthesia.

The American Association of Nurse Anesthetists (AANA) and the American Society of Anesthesiologists (ASA) have identified several basic intermittent and continuous physical monitors that should be applied to all patients when administering anesthesia.[21] The AANA Standards of Nurse Anesthesia Practice states under Standard Nine to, "Continuously monitor oxygenation by clinical observation and pulse oximetry."[22] Furthermore, the ASA's Standards for Basic Anesthetic Monitoring states under Section Two, "During all anesthetics, a quantitative method of assessing oxygenation such as pulse oximetry shall by employed."[21] The pulse

oximeter is typically placed on one of the patient's fingers, often in the preoperative area prior to the arrival of the anesthesia provider. The anesthesia providers at one of the locations included in this study had a departmental policy in place, recommending the pulse oximeter be placed on the fourth finger of the non-dominant hand. The rationale for this measure was to prevent the patient from inadvertently scratching the face or eyes while emerging from anesthesia. There is currently no data to support this recommendation, however the potential benefit of reducing perioperative corneal abrasions by placing the pulse oximeter on the fourth finger of the non-dominant hand seem to have no untoward consequences. This is certainly a simple measure that can be employed to potentially reduce the risk of corneal abrasions in the surgical population.

Numerous facilities have begun instituting a department of anesthesiology-based approach to managing minor corneal abrasions. This approach operates under the assumption that simple perioperative corneal abrasions can be managed by non-specialists, such as ophthalmologists, in the immediate post-operative recovery period due to the simplicity of treatment options and the low risk for long-term damage. The management consists of an algorithm approved by the facility that includes a formal assessment provided by the Anesthesiologist, intervening with artificial tears and/or ophthalmic antibiotics, and performing a follow up assessment within 24 hours, at which time the Anesthesiologist will determine the necessity for an Ophthalmology consultation. A recent study determined that an anesthesiology-based approach reduced the time between the patient experiencing eye pain and the initiation of treatment, resulting in improved patient comfort and satisfaction.[23] To date, all anesthesiology-based approaches to managing perioperative corneal abrasions are facility specific. We were unable to find an agreed upon guideline that is supported by either the AANA, ASA, or the

American Academy of Ophthalmology. In both the pre and post-test, the participants were asked if minor perioperative corneal abrasions can be safely managed by an anesthesiology-based approach. The sites included in this study did not have a formal anesthesiology-based perioperative corneal abrasion policy in place. Furthermore, according to the participants, the CRNAs in these sites were not involved with immediate post-operative corneal abrasion management. These are possible reasons why many CRNAs included in this study did not have a baseline understanding of an anesthesiology-based approach, while all of the Anesthesiologists in this study correctly identified an anesthesiology-based approach as an appropriate method to manage minor perioperative corneal abrasions. Furthermore, the lack of improvement in the post test scores demonstrates that a more involved form of education might be necessary to ensure that all anesthesia providers understand an anesthesiology-based approach to perioperative corneal abrasion management. Even if CRNAs are not involved with the management of corneal abrasions in all facilities, having a baseline understanding can assist Anesthesiologists in intervening quicker, potentially improving patient safety and satisfaction.

An anesthesiology-based approach to perioperative corneal abrasion management includes the application of artificial tears and topical ophthalmic antibiotics while small abrasions do not require a specific intervention.[23] This question was presented in the pre and post-test as a multiple answer format, with patching of the affected eye and chronic local anesthetic drops representing incorrect distractors Only 20% of the participants answered correctly prior to the educational in-service, increasing to 40% on the post-test. On the other hand, 100% of participants understand the appropriate time to consult ophthalmology in the post-operative period. The participants were asked several additional questions during the

educational in-service regarding corneal abrasion management, specifically the use of antibiotics and the timing of administration. As with the previous question regarding the anesthesiology-based approach to perioperative corneal abrasion management, there are a few possible reasons for the lack of consensus among the participants. First, the participants in this study included Anesthesiologists and CRNAs, however only the Anesthesiologists are involved in the post-operative management of patients at these specific facilities. Second, perioperative corneal abrasions are a rare occurrence.[2-4] Finally, this topic seems to be an emerging area without a clear set of guidelines agreed upon by the ASA, the American Association of Nurse Anesthetists, or the American Academy of Ophthalmology. This lack of clarity on recommended guidelines may impact anesthesia providers' understanding of an anesthesiology-based approach to perioperative corneal abrasion management.

The departmental standard for both facilities included in this project recommends documentation of perioperative taping of the eyelids. Most (92%) of the participants correctly identified that their respective departments recommend documenting when and in what manner the patient's eyes are taped during the perioperative period. With the advent of electronic charting and pre-filled data sets it is easy to forget the necessity of proper documentation throughout the perioperative period. Proper documentation helps to ensure safe delivery of anesthesia and provide data for quality improvement measures.

We concluded that the anesthesia providers in this study demonstrated a basic understanding of perioperative corneal abrasion prevention practices and the use of an in-person educational intervention improved their understanding of this topic. The topics with the greatest

improvement included the efficacy of tape alone when protecting the eyes of the patient, the optimal placement of the pulse oximeter probe, and the components of an anesthesiology-based perioperative corneal abrasion management. The efficacy of utilizing tape alone was the only topic that demonstrated a significant increase from pre to post-test score (*p*-value 0.046). Risk factors for perioperative corneal abrasions, the proper time to apply tape to the patient's eyes, and the efficacy of an anesthesiology-based approach to perioperative corneal abrasions were areas that demonstrated a decreased test score. This could possibly be attributed to memory decay due to the post-test taking place one month after the educational intervention.

Most of the anesthesia providers in this study reported using effective perioperative corneal abrasion prevention techniques in their practice at baseline. These prevention techniques included taping the patient's eyes after induction but prior to intubation, placing the pulse oximeter on nondominant hand, and using an eye guard when the patient is prone. Very few participants reported always using eye ointment during general anesthesia. This is interesting considering many participants were not familiar with the data supporting the use of tape without ointment during general anesthesia. Perhaps the providers were basing their decisions on anecdotal experience or personal preference.

While the educational in-service improved the participant's understanding of perioperative corneal abrasion prevention, it did not demonstrate a significant impact on anesthesia providers' perioperative corneal abrasion practices as evidenced by a *p*-value between 0.213 and 0.277. Possible reasons for the lack of impact on anesthesia providers' practices include the effective use of techniques at baseline, the short time frame between the pre and post-

tests, or the educational intervention was not convincing enough to alter the providers' practices. Interestingly, most of participants felt that an educational in-service would "likely" or "very likely" have an impact on their perioperative corneal abrasion practices. Perhaps the significance of an educational in-service would be more apparent if the in-service was longer than 15 minutes or if participants were given more time to implement changes to their practice.

Limitations

Primary limitations of this study include the lack of generalizability. Only two hospitals were utilized in this study, with close proximity to one another. Furthermore, only 40 anesthesia providers participated, and most of the participants were CRNAs. If more participants were included and Anesthesiologists and CRNAs were evenly distributed, there is a possibility that the results would be significantly different from this study. The number of participants were not evenly distributed between the two hospitals; however, the demographic data was similar.

The educational intervention was also a limitation of this study. The educational in-service took place early in the morning. This could have influenced the attention span and alertness of the participants. Bias may have been a factor as the primary investigator also conducted the educational intervention. The in-service was approximately 15 minutes long, which is considerably shorter than the 45-minute-long educational intervention utilized by others who have conducted similar studies such as Martin et al.[9]

Finally, the primary investigator was unable to ensure that all providers who participated in the pre-test and in-service returned to take the post-test. This study took place during the weekly departmental meetings and participant's work schedules were not consistent during the timeframe of the study.

Implications

Previous studies have identified the risk factors associated with perioperative corneal abrasions and preventative measures that are effective in reducing corneal abrasion incidences.[2-4,8,10-12,15-18] Furthermore, Martin et al. concluded that a structured perioperative corneal abrasion prevention performance improvement system, including an in person educational intervention significantly reduced corneal abrasion incidences.[9] While this study did not demonstrate statistical significance, the anesthesia providers demonstrated improved understanding of perioperative corneal abrasion prevention after participating in the educational in-service. The study did find the educational intervention to have a statistically significant impact on anesthesia providers' perioperative corneal abrasion prevention practices, but 80% of participants in this study report that an educational intervention would "likely or very likely" impact their preventative practices. With this information, the primary investigator hypothesizes that future educational interventions, albeit in a different format, on this topic are warranted. Improving the understanding or reiterating the importance of current perioperative corneal abrasion prevention practices could increase patient safety, improve patient satisfaction, and reduce financial cost.

Future Recommendations

There are several ways this topic can be studied further. One of the limitations of this study included the lack of generalizability due to only two hospitals and 40 participants involved. Replicating a similar study on a larger scale with hospitals of differing sizes and geographic locations could result in statistically significant data. Including a larger number and wider variety of participants, including Anesthesiologists, Resident Anesthesiologists, CRNAs, and SRNAs could have changed the results of this study. Also, the efficacy of an educational intervention might be more pronounced in residents and students rather than Anesthesiologists and CRNAs due to lack of professional experience.

The educational intervention itself was recognized as a limitation in this study. The primary investigator recommends further research using a different format. Perhaps a longer presentation would have a more meaningful effect on provides' understanding and ability to recall the information. Recording a premade lecture can further reduce the bias present in this study as well as slight differences in how the subject matter was presented to participants. Surveying anesthesia providers regarding preferred learning modalities could also assist in developing more effective educational methods. Scheduling a time during the day other than early in the morning might result in more participation and effectiveness as well.

The loss of participants to follow-up was another limitation identified in this study. The primary investigator recommends developing a way to ensure that all participants in a future educational intervention participate in data collection at the same time. This would eliminate

differences in the time frame between the delivery of the educational information and the post-test assessment as well as generalized lack of data for the study.

Conclusion

This study determined that anesthesia providers have a basic understanding of perioperative corneal abrasion prevention methods, however there is room for improvement as evidenced by the pre-test scores. The educational intervention used in this study did not have a significant association with improved understanding of perioperative corneal abrasion prevention understanding ($p = 0.171$) or a significant impact on anesthesia providers' prevention methods ($p = 0.213$-0.277) however post-test scores did improve from 76% to 82%. Furthermore, most anesthesia providers included in this study (80%) feel that an educational intervention would have a significant impact on their corneal abrasion prevention methods. Continued perioperative corneal abrasion prevention education is warranted as the benefits of reduced corneal abrasions, including improved patient comfort, patient satisfaction, and reduced cost to the patient, outweigh the cost of an educational in-service.

APPENDIX A

Informed Consent

You are invited to participate in a research study titled "Perioperative Corneal Abrasion: An exploration of educational intervention effectiveness and impact on prevention practices". This study is being conducted by Aaron Gonzalez-Birr, Student Registered Nurse Anesthetist, Georgetown University in fulfillment of the University's curricular requirement for the degree of Doctor of Nurse Anesthesia Practice (DNAP). Co-Investigators are DNAP program director, Dr. Ladan Eshkevari PhD, CRNA, and DNAP assistant program director, Dr. Carrie Bowman Dalley PhD, CRNA.

This study aims to determine: (1) What is the anesthesia providers' level of understanding of perioperative corneal abrasion prevention practices? (2) Does an educational intervention impact the anesthesia providers' understanding of perioperative corneal abrasion prevention practices? (3) Does an educational intervention impact anesthesia providers' current perioperative corneal abrasion prevention practices?

You are being asked to take part in this study because you are a currently practicing board-certified Anesthesiologist or Certified Registered Nurse Anesthetist in the Inova Alexandria (or Inova Fair Oaks) department of anesthesia. If you agree to participate, you will be asked to take part in a 19 question pre-test, which will take approximately 10 minutes, followed by a 15 minute in person educational in-service. (At a later date) you will be asked to complete a 15 question post-test, which will take approximately 10 minutes. The tests will cover perioperative corneal abrasion practices and current recommendations. The study will be held during the (insert dates) in the conference room. The test results included in this study will be anonymous.

Participation in this study is entirely voluntary at all times. You can choose not to participate at all or to ask to discontinue your participation at any time. Regardless of your decision, there will be no effect on your relationship with the researchers nor include any untoward consequences.

Upon completion, informed consent forms and tests will be scanned into a password protected file and the hard copies will be shredded.

There are no risks associated with this study. Possible direct benefits from participation include improved understanding of current perioperative corneal abrasion practices. Indirect benefits from the information may be helpful in reducing perioperative corneal abrasion incidences, improving patient satisfaction, and reducing healthcare center costs.

If you have any questions regarding the interview or this research project in general, please contact the principal investigator, Aaron Gonzalez-Birr, at (361) 739-2559 or by e-mail at arg121@georgetown.edu.

If you have any questions about your rights as a research participant, please contact the Georgetown University IRB at (202) 687-6553 or irboard@georgetown.edu.

By taking part in this in-service, you are indicating your consent to participate in this study.

Thank you in advance for your time

Aaron Gonzalez-Birr, RN, BSN
Student Registered Nurse Anesthetist
Georgetown University School of Nursing and Health Studies
arg121@georgetown.edu
(361)-739-2559

APPENDIX B

Pre/Post Test

Part 1:

1. What is your title?
   A. Anesthesiologist
   B. Certified Registered Nurse Anesthetist

2. What is your gender?
   A. Male
   B. Female
   C. Other

3. What is your age?
   A. < 30 years
   B. 30-39 years
   C. 40-49 years
   D. 50-59 years
   E. 60-69 years
   F. > 70 years

4. How many years have you been in practice?
   A. < 1 year
   B. 1-5 years
   C. 6-10 years
   D. 10-15 years
   E. > 15 years

5. How many hours do you practice each week?
   A. < 12 hours
   B. 12-24 hours
   C. 25-40 hours
   D. 40-60 hours
   E. > 60 hours

Part 2:

   A. Which etiologic factor is not associated with perioperative corneal abrasions?
   A. Impaired tear production
   B. Chemical injury

C. Increased corneal perfusion
D. Incomplete eyelid closure during surgery
E. Direct trauma

B. Which of the following are not risk factors of perioperative corneal abrasions?
A. Head and neck procedures
B. Prolonged procedure
C. Advanced age
D. Prone and lateral position
E. Obese patient

8. The use of ophthalmic lubricant in addition to taping the eyes is superior to taping eyes alone.
A. True
B. False

9. It is recommended to tape the eyes of a surgical patient
A. As soon as the patient's endotracheal tube is secure
B. Immediately after loss of eyelid reflex
C. After administration of a neuromuscular blocker
D. After the patient is draped

10. The pulse oximeter should be placed on the which finger of the non-dominant hand.
A. Index finger
B. 3rd finger
C. 4th finger
D. 5th finger

11. Evidence has shown that minor perioperative corneal abrasions can be managed using an anesthesiology-based approach.
A. True
B. False

12. Perioperative corneal abrasion management includes: (choose three)
A. Artificial tears q 30 minutes for 2-3 hours
B. Topical ophthalmic antibiotics
C. Patching of the affected eye
D. Chronic local anesthetic drops
E. Small abrasions require no specific intervention

13. An ophthalmology consult is necessary if the patient experiences:
A. Loss of vision
B. Change in visual acuity

C. Foreign body
D. Unresolved symptoms after 24 hrs
E. All of the above

14. North American Partners in Anesthesia recommends documentation of perioperatieve taping of the eyes in all cases involving general anesthesia.
A. True
B. False

Part 3:

15. How often do you tape the eyes of the patient after induction but prior to intubation?
A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

16. How often do you use Lacri-Lube during general anesthesia?
A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

17. How often do you place the pulse oximeter on the non-dominant hand?
A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

18. How often do you use an eye guard when a patient is in the prone position?
A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

19. How much of an impact does an educational in-service have on your perioperative corneal abrasion practices.
A. Not at all
B. Not likely
C. Neutral
D. Likely
E. Very likely

Post Test

Part 1:

1. What is your title?
   A. Anesthesiologist
   B. Certified Registered Nurse Anesthetist

2. What is your gender?
   A. Male
   B. Female
   C. Other

3. What is your age?
   A. < 30 years
   B. 30-39 years
   C. 40-49 years
   D. 50-59 years
   E. 60-69 years
   F. > 70 years

4. How many years have you been in practice?
   A. < 1 year
   B. 1-5 years
   C. 6-10 years
   D. 10-15 years
   E. > 15 years

5. How many hours do you practice each week?
   A. < 12 hours
   B. 12-24 hours
   C. 25-40 hours
   D. 40-60 hours
   E. > 60 hours

Part 2:

C. Which etiologic factor is not associated with perioperative corneal abrasions?
A. Impaired tear production
B. Chemical injury
C. Increased corneal perfusion
D. Incomplete eyelid closure during surgery

E. Direct trauma

D. Which of the following are not risk factors of perioperative corneal abrasions?
A. Head and neck procedures
B. Prolonged procedure
C. Advanced age
D. Prone and lateral position
E. Obese patient

8. The use of ophthalmic lubricant in addition to taping the eyes is superior to taping eyes alone.
A. True
B. False

9. It is recommended to tape the eyes of a surgical patient
A. As soon as the patient's endotracheal tube is secure
B. Immediately after loss of eyelid reflex
C. After administration of a neuromuscular blocker
D. After the patient is draped

10. The pulse oximeter should be placed on the which finger of the non-dominant hand.
A. Index finger
B. 3rd finger
C. 4th finger
D. 5th finger

11. Evidence has shown that minor perioperative corneal abrasions can be managed using an anesthesiology-based approach.
A. True
B. False

12. Perioperative corneal abrasion management includes: (choose three)
A. Artificial tears q 30 minutes for 2-3 hours
B. Topical ophthalmic antibiotics
C. Patching of the affected eye
D. Chronic local anesthetic drops
E. Small abrasions require no specific intervention

13. An ophthalmology consult is necessary if the patient experiences:
E. Loss of vision
F. Change in visual acuity
G. Foreign body
H. Unresolved symptoms after 24 hrs

I. All of the above

14. North American Partners in Anesthesia recommends documentation of perioperatieve taping of the eyes in all cases involving general anesthesia.

A. True

B. False

Part 3:

15. How often do you tape the eyes of the patient after induction but prior to intubation?

F. Never
G. Rarely
H. Sometimes
I. Often
J. Always

16. How often do you use Lacri-Lube during general anesthesia?

K. Never
L. Rarely
M. Sometimes
N. Often
O. Always

17. How often do you place the pulse oximeter on the non-dominant hand?

P. Never
Q. Rarely
R. Sometimes
S. Often
T. Always

18. How often do you use an eye guard when a patient is in the prone position?

U. Never
V. Rarely
W. Sometimes
X. Often
Y. Always

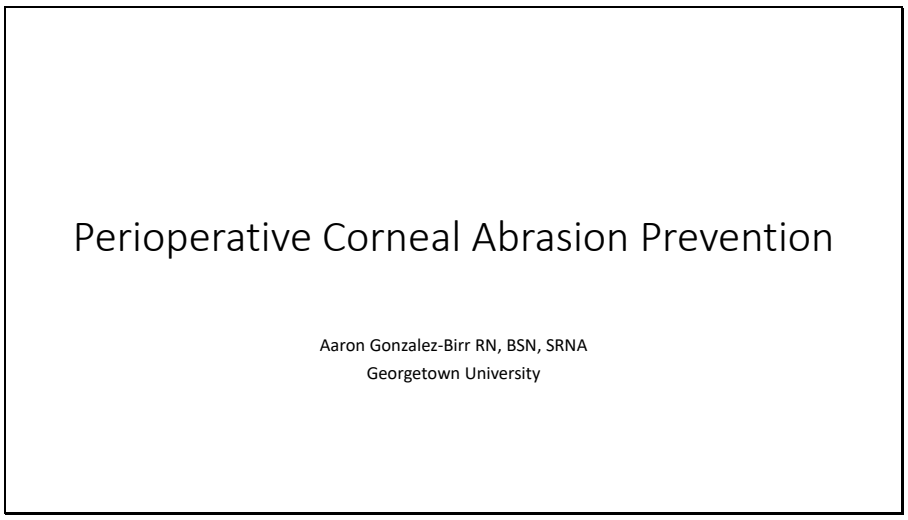
19. How much of an impact does an educational in-service have on your perioperative corneal abrasion practices.

A. Not at all
B. Not likely
C. Neutral
D. Likely
E. Very likely

APPENDIX C

Inservice Powerpoint

Slide 1:



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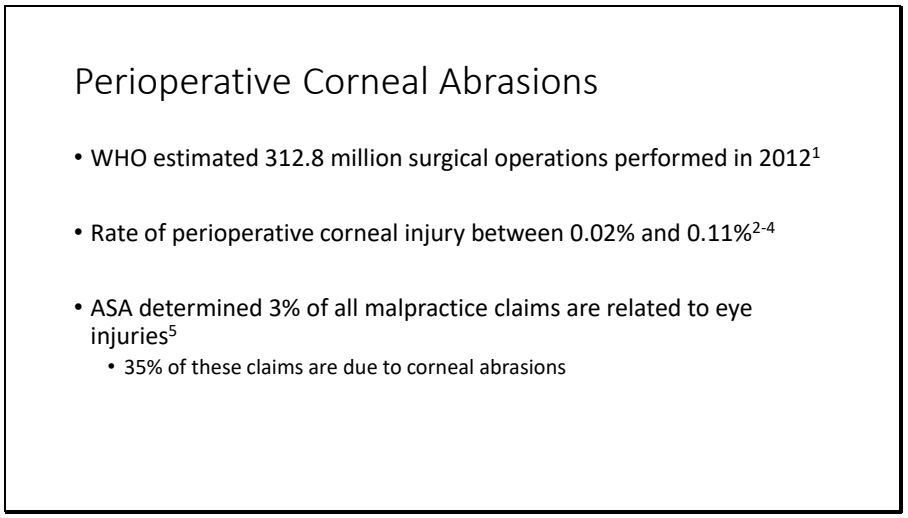


Slide 3:

What is a Corneal Abrasion

- Cornea
  - Avascular connective tissue on the outermost layer of the eye
  - Primary structural and infectious barrier
- Corneal Abrasion – scratch or cut on the corneal epithelium, the outermost layer of the cornea
- Pathogenesis[6]
  - Physical Trauma
  - Exposure Keratopathy

Slide 4:

Altered Natural Protection

- Reduced reflex tearing[7]
- Reduced basal tear production[8]
- Abolished blinking reflex[7]
- Lagophthalmos[7]
- Reduced Bell's phenomenon[7]

Slide 5:

Risk Factors

- Longer procedures (>60-90 minutes)[2-4]
- Prone, Lateral, Steep Trendelenburg positioning [2-4]
- Procedures taking place near the face or eyes[2-4]

- Older patients*[2-4]
- Oxygen delivery device[3-4]
- Anemia[3]
- Deliberate perioperative hypotension[3]

Slide 6:

Prevention Methods

- Screen patients for risk factors[2-4]
  - Dry eyes
  - Chronic use of tear drops
  - History of corneal abrasions
  - Grave's Disease
  - Diabetes

Slide 7:

Prevention Methods

- Tape eyes in horizontal fashion immediately after induction and prior to intubation[12,13]

- Plastic, Silk, Paper Tape[6]
- Bio-occlusive Dressings (Tegaderm, Opsite)[6]
- Hydro-gel Patch[6]

Slide 8:

Prevention Methods

- No significant reduction in corneal abrasions with ocular ointments[12]
- Fat-based Ointments[6]
  - Increased risk of blurred vision, local allergic reactions, photophobia, foreign body sensation
  - Flammable
  - Not recommended
- Water-based Ointments[6]
  - Low complication rate
  - Prolongs tear film break-up time
  - Preservative-free is recommended

Slide 9:

Prevention Methods

- Utilize an eye shield for high risk procedures (prone, steep Trendelenburg)
- Check regularly for compression intra-op
- Ideally, place pulse oximeter on ring finger of non-dominant hand
  - Avoid the index finger of dominant hand

Slide 10:

Anesthesiology-Based Approach to Perioperative Corneal Abrasion Management

- Minor perioperative corneal abrasions can safely be managed with an Anesthesiology-Based Approach[10]
  - Reduced time to treatment
  - Improved patient comfort and satisfaction
- Utilize artificial tears (Refresh Tears Plus Eye Drops)[10]
- Topical ophthalmic antibiotic (0.5% Erythromycin ointment)[10]

Slide 11:

References

1. Weiser T, Haynes A, Molina G, et al. Size and distribution of the global volume of surgery in 2012. *Bull World Health Organ*. 2016;94:201-209.

2. Roth S, Thisted RA, Erickson JP, Black S, Schreider BD. Eye injuries after nonocular surgery. A study of 60,965 anesthetics from 1988 to 1992. *Anesthesiology*. 1996;85(5):1020-1027.

3. Yu H, Chou A, Yang M, Chang C. An analysis of perioperative eye injuries after nonocular surgery. *Acta Anaesthesiologica Taiwanica*. 2010;48(3):122-129. doi: 10.1016/S1875-4597(10)60043-4.

4. Segal KL, Fleischut PM, Kim C, et al. Evaluation and treatment of perioperative corneal abrasions. *Journal of Ophthalmology*. 2014;2014. doi: 10.1155/2014/901901.

5. Gild WM, Posner KL, Caplan RA, Cheney FW. Eye injuries associated with anesthesia: A closed claims analysis. *Anesthesiology*. 1992;76(2):204-208.

Slide 12:

References

6. Grixti A, Sadri M, Watts MT. Corneal protection during general anesthesia for nonocular surgery. *The Ocular Surface*. 2013;11(2):109-118. doi: 10.1016/j.jtos.2012.10.003.

7. Malafa MM, Coleman JE, Bowman RW, Rohrich RJ. Perioperative corneal abrasion: Updated guidelines for prevention and management. *Plastic & Reconstructive Surgery*. 2016;137(5):8e.

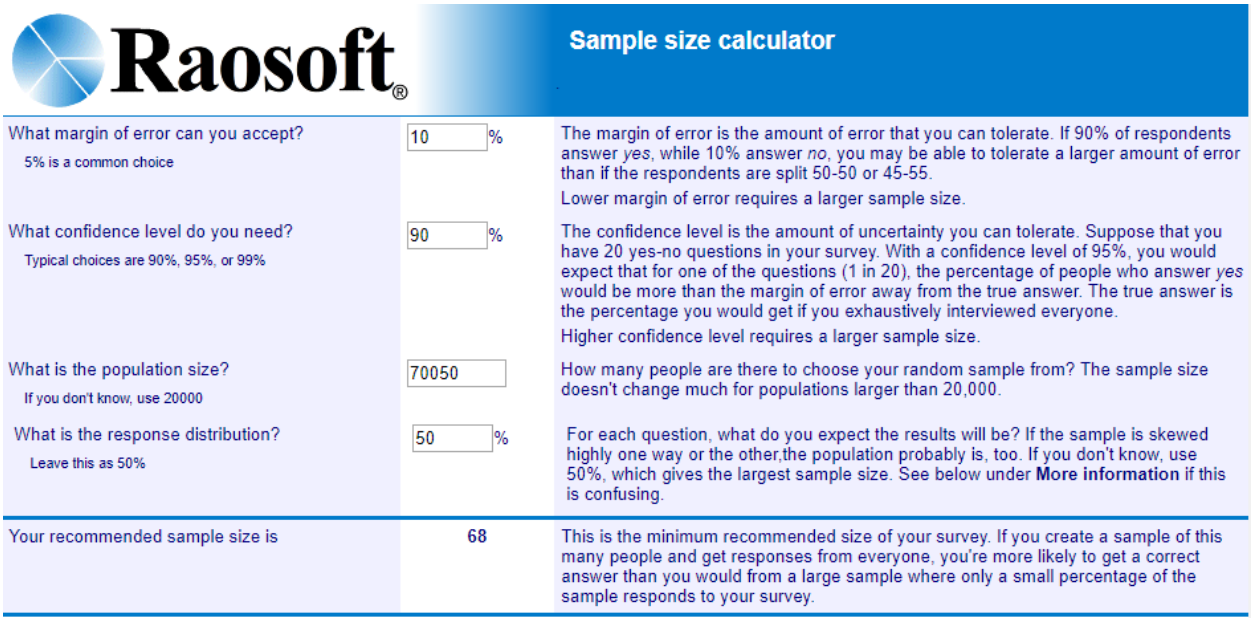
8. Cross D, Krupin T. Implications of the effects of general anesthesia on basal tear production. *Anesthesia and Analgesia*. 1977;56(1):35-37.

9. Siffring PA, Poulton TJ. Prevention of ophthalmic complications during general anesthesia. *Anesthesiology*. 1987;66:569-570.

10. Lichter JR, Marr LB, Schilling DE. A Department-of-Anesthesiology-based management protocol for perioperative corneal abrasions. *Clin Ophthalmol*. 2015;11(9):1689-95

APPENDIX D

Raosoft Sample Size Calculator



APPENDIX E

Site Permission

Re: corneal abrasion quality improvement project
Umadevi Rangarajan, MD
Thu 11/1/2018 8:58 PM
To:Aaron Gonzalez-Birr <agonzalezbirr@napaanesthesia.com>;
Hi Aaron,

Happy to participate when you are ready to quiz!

Good Luck,
Uma
Umadevi Rangarajan, MD
Chair, NAPA at Inova Fair Oaks Hospital
Inova Fair Oaks Hospital
North American Partners in Anesthesia
urangarajan@napaanesthesia.com
NAPAanesthesia.com

From: Aaron Gonzalez-Birr
Sent: Thursday, November 1, 2018 3:36 PM
To: Umadevi Rangarajan, MD
Subject: Re: corneal abrasion quality improvement project

Dr. Rangarajan,

Thank you for the reply Dr. Rangarajan. My name is Aaron Gonzalez-Birr and I am in my second year of Georgetown University's Nurse Anesthesia program. I was going to give you a quick summary of my program's expectations as well as what I am trying to accomplish with this project.

I am in a Doctor of Nurse Anesthesia program. Similar to a Doctor of Nursing Practice, this is more clinically focused rather than a researched focused PhD . One of our program's requirements is a scholarly project. In general, this is less involved than a full blown dissertation. We also have far less time to complete our design, data collection, and manuscript. The timeline our faculty set for us is to design our study during this semester and collect our data during the spring.

My project is rather simple in design. I am planning to give a pre-test covering information and current practice recommendations regarding perioperative corneal abrasions prevention. This will be followed by an educational inservice. At a predetermined time afterwards I would conduct a post-test. What I am specifically looking for is anesthesia provider's baseline level of understanding of current evidence based data regarding this topic and whether an educational inservice would have an effect on the provider's willingness to change their current practices (or if they even need to be altered in the first place). (As a side note, Dr. Lee is also curious whether practitioners are remembering his clinical advisory emails.)

At this time I am still in the process of editing my literature review and methodology documentation due to some unexpected changes to my project earlier this semester. I will forward them to you as soon as they are compete and reviewed by my faculty and Dr. Lee.

Thank you again and I look forward to working with you. I am happy to answer any questions you might have.

Regards,

Aaron Gonzalez-Birr SRNA
Georgetown University
Cell: 361-739-2559

From: Umadevi Rangarajan, MD
Sent: Tuesday, October 30, 2018 5:48 PM
To: Brent Lee, MD, MPH; Burt, Matthew L.
Cc: Aaron Gonzalez-Birr
Subject: Re: corneal abrasion quality improvement project

Sure, Brent.

Uma
Umadevi Rangarajan, MD
Chair, NAPA at Inova Fair Oaks Hospital
Inova Fair Oaks Hospital
North American Partners in Anesthesia
urangarajan@napaanesthesia.com
NAPAanesthesia.com

From: Brent Lee, MD, MPH
Sent: Tuesday, October 30, 2018 4:30 PM
To: Burt, Matthew L.; Umadevi Rangarajan, MD
Cc: Aaron Gonzalez-Birr
Subject: corneal abrasion quality improvement project

Matt and Uma,

Aaron Gonzalez-Birr (cc'd on this email) is a Georgetown SRNA working on his doctorate project and would like to conduct a quality project focusing on corneal abrasion education and the impact it could have on anesthesia provider practice. Since he is in the local area, we thought that both of your hospitals would be ideal for him to do this project.

I will let Aaron introduce his idea to you.

I hope you will be able to help him by working collaboratively on this project with him.

Thanks,

Brent

Brent Lee, MD, MPH
Director of Clinical Excellence and Performance Improvement
North American Partners in Anesthesia
11781 Lee Jackson Memorial, Suite 550
Fairfax, Virginia 22033
O: 571-777-5500
F: 703-890-3066
blee@napaanesthesia.com
NAPAanesthesia.com

From: Burt, Matthew L. <Matthew.Burt@inova.org>
Sent: Thursday, November 08, 2018 3:25 PM
To: Aaron Gonzalez-Birr
Subject: RE: EXTERNAL: Re: corneal abrasion quality improvement project

Hi Aaron,

We have 22 CRNA's and 9 MD's. Looking forward to seeing your project.

From: Aaron Gonzalez-Birr [mailto:agonzalezbirr@napaanesthesia.com]
Sent: Thursday, November 08, 2018 2:55 PM
To: Burt, Matthew L.
Subject: Re: EXTERNAL: Re: corneal abrasion quality improvement project

Dr. Burt,

Thank you for the reply Dr. Burt. My name is Aaron Gonzalez-Birr and I am in my second year of Georgetown University's Nurse Anesthesia program. I was going to give you a quick summary of my program's expectations as well as what I am trying to accomplish with this project.

I am in a Doctor of Nurse Anesthesia program. Similar to a Doctor of Nursing Practice, this is more clinically focused rather than a researched focused PhD . One of our program's requirements is a scholarly project. In general, this is less involved than a full blown dissertation. We also have far less time to complete our design, data collection, and manuscript. The timeline our faculty set for us is to design our study during this semester and collect our data during the spring.

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At this time I am still in the process of editing my literature review and methodology documentation due to some unexpected changes to my project earlier this semester. I will forward them to you as soon as they are compete and reviewed by my faculty and Dr. Lee.

For the time being, would you be able to provide me with the number of currently practicing Anesthesiologists and CRNAs at your facility?

Thank you again and I look forward to working with you. I am happy to answer any questions you might have.

Regards,

Aaron Gonzalez-Birr, SRNA
Georgetown University
Cell: 361-739-2559

From: Burt, Matthew L. <Matthew.Burt@inova.org>
Sent: Sunday, November 4, 2018 7:13 PM
To: Umadevi Rangarajan, MD; Brent Lee, MD, MPH
Cc: Aaron Gonzalez-Birr
Subject: EXTERNAL: Re: corneal abrasion quality improvement project

Sure!

Matthew Burt, MD
Chairman of Anesthesiology
INOVA Alexandria

On October 30, 2018 at 5:49:16 PM EDT, Umadevi Rangarajan, MD <urangarajan@napaanesthesia.com> wrote:
Sure, Brent.

Uma
Umadevi Rangarajan, MD
Chair, NAPA at Inova Fair Oaks Hospital
Inova Fair Oaks Hospital
North American Partners in Anesthesia
urangarajan@napaanesthesia.com
NAPAanesthesia.com

From: Brent Lee, MD, MPH
Sent: Tuesday, October 30, 2018 4:30 PM
To: Burt, Matthew L.; Umadevi Rangarajan, MD
Cc: Aaron Gonzalez-Birr
Subject: corneal abrasion quality improvement project

Matt and Uma,

Aaron Gonzalez-Birr (cc'd on this email) is a Georgetown SRNA working on his doctorate project and would like to conduct a quality project focusing on corneal abrasion education and the impact it could have on anesthesia provider practice. Since he is in the local area, we thought that both of your hospitals would be ideal for him to do this project.

I will let Aaron introduce his idea to you.

I hope you will be able to help him by working collaboratively on this project with him.

Thanks,

Brent

Brent Lee, MD, MPH
Director of Clinical Excellence and Performance Improvement
North American Partners in Anesthesia
11781 Lee Jackson Memorial, Suite 550
Fairfax, Virginia 22033
O: 571-777-5500
F: 703-890-3066
blee@napaanesthesia.com
NAPAanesthesia.com

REFERENCES

1. Weiser T, Haynes A, Molina G, et al. Size and distribution of the global volume of surgery in 2012. *Bull World Health Organ*. 2016;94:201-209.

2. Roth S, Thisted RA, Erickson JP, Black S, Schreider BD. Eye injuries after nonocular surgery. A study of 60,965 anesthetics from 1988 to 1992. *Anesthesiology*. 1996;85(5):1020-1027. http://proxy.library.georgetown.edu/login?url=http://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med4&AN=8916818.

3. Yu H, Chou A, Yang M, Chang C. An analysis of perioperative eye injuries after nonocular surgery. *Acta Anaesthesiologica Taiwanica*. 2010;48(3):122-129. http://www.sciencedirect.com/science/article/pii/S1875459710600434. Accessed Jul 10, 2018. doi: 10.1016/S1875-4597(10)60043-4.

4. Segal KL, Fleischut PM, Kim C, et al. Evaluation and treatment of perioperative corneal abrasions. *Journal of Ophthalmology*. 2014;2014. https://www.hindawi.com/journals/joph/2014/901901/. Accessed Jul 10, 2018. doi: 10.1155/2014/901901.

5. Gild WM, Posner KL, Caplan RA, Cheney FW. Eye injuries associated with anesthesia: A closed claims analysis. *Anesthesiology*. 1992;76(2):204-208.

6. Ahmed F, House RJ, Feldman BH. Corneal abrasions and corneal foreign bodies. *Primary Care: Clinics in Office Practice*. 2015;42(3):363-375. http://www.sciencedirect.com/science/article/pii/S0095454315000378. Accessed Jul 12, 2018. doi: 10.1016/j.pop.2015.05.004.

7. Wong T, Lincoln A, Tielsch J, Baker S. The epidemiology of ocular injury in a major US automobile corporation. *Eye*. 1998;12:870-874.

8. Malafa MM, Coleman JE, Bowman RW, Rohrich RJ. Perioperative corneal abrasion: Updated guidelines for prevention and management. *Plastic & Reconstructive Surgery*. 2016;137(5):8e. http://proxy.library.georgetown.edu/login?url=http://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med8&AN=27119941.

9. Martin DP, Weingarten TN, Gunn PW, et al. Performance improvement system and postoperative corneal injuries: Incidence and risk factors. *Anesthesiology*. 2009;111(2):320-326. https://www.ncbi.nlm.nih.gov/pubmed/19602956. doi: 10.1097/ALN.0b013e3181ae63f0.

10. Batra YK, Bali IM. Corneal abrasions during general anesthesia. *Anesth Analg.* 1977;56:363-365.

11. Grixti A, Sadri M, Watts MT. Corneal protection during general anesthesia for nonocular surgery. *The Ocular Surface*. 2013;11(2):109-

118. http://www.sciencedirect.com/science/article/pii/S1542012413000128. Accessed Jul 12, 2018. doi: 10.1016/j.jtos.2012.10.003.

12. Lavery HJ, Samadi DB, Gainsburg DM. Preventing ocular injuries during robotic prostatectomy: A simple technique (abstract of poster presentation at the 25th annual congress of the european association of urology in barcelona). *Eur Urol Suppl*. 2010;9

13. DelMonte D, Kim T. Anatomy and physiology of the cornea. *Journal of Cataract & Refractive Surgery*. 2011;37(3):588-598.

14. Cross D, Krupin T. Implications of the effects of general anesthesia on basal tear production. *Anesthesia and Analgesia*. 1977;56(1):35-37.

15. Wan T, Wang Y, Jin X. Corneal injury and its protection using hydro-gel patch during general anesthesia. *Int J Ophthalmol*. 2014;7(6).

16. Siffring PA, Poulton TJ. Prevention of ophthalmic complications during general anesthesia. *Anesthesiology*. 1987;66:569-570.

17. Hardberger R, Hanna C, Boyd C. Effects of drug vehicles on ocular contact time. *Arch Ophthalmol*. 1975;93:42-45.

18. Grover V, Kumar K, Sharma S, Sethi N, Grewal S. Comparison of methods of eye protection under general anesthesia. *Can J Anaesth*. 1998;45(6):575-577.

19. Occupational employment and wages, may 2016 29-1061 anesthesiologists. Bureau of Labor Statistics. https://www.bls.gov/oes/2016/may/oes291061.htm Published 2017. Accessed November 19, 2018.

20. Occupational employment and wages, may 2016 29-1151 nurse anesthetists. Bureau of Labor Statistics. https://www.bls.gov/oes/2016/may/oes291151.htm Published 2017. Accessed November 19, 2018.

21. Eichhorn J. Pulse Oximetry as a standard of practice in anesthesia. *Anesthesiology.* 1993;78(3):423-6

22. American Association of Nurse Anesthetists. Standards for Nurse Anesthesia Practice. *AANA Professional Practice Manual*. www.aana.com/practice/practice-manual. Published 2019. Accessed January 15, 2019.

23. Lichter JR, Marr LB, Schilling DE. A Department-of-Anesthesiology-based management protocol for perioperative corneal abrasions. *Clin Ophthalmol.* 2015;11(9):1689-95

24. Ebbinghaus H. Über das Gedächtnis. Leipzig: Dunker. 1880

25. Ebbinghaus H. Memory: A contribution to experimental psychology. Ruger HA, Bussenius CE, translator. (1913/1885) New York: Teachers College, Columbia University.

26. Murre JMJ, Dros J. Replication and Analysis of Ebbinghaus' Forgetting Curve. 2015. *PLoS ONE*. 2015;10(7)