Assessing the Adequacy of a Newly Developed Corneal Abrasion Prevention Guide in High-Risk Cases (Spinal Surgeries) at A Large Academic Medical Center

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Notes from the Author

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Abstract

Corneal abrasions can occur during and after general anesthesia. CRNAs are required to ensure protective measures are implemented, remain intact throughout the duration of surgery, and to document protection measures implemented. There are currently no nationally recommended standards of practice for CRNAs to implement to protect their patients from perioperative corneal abrasions. The purpose of this QI project was to assess CRNAs' preferences and practices regarding eye care and corneal abrasion prevention and whether or not they perceived a newly developed corneal abrasion quick reference guide as a useful tool for their practice to prevent corneal abrasions. In this QI project, a simple educational initiative involving the use of a corneal abrasion quick reference guide and educational PowerPoint improved CRNA reported confidence in their ability to identify patients at high risk, implement appropriate prevention practices, and diagnose and treat corneal abrasions. CRNAs reported that the corneal abrasion quick reference guide was useful for their practice, was a good reminder of high risk cases, and provided guidance on how to best prevent corneal abrasions. This QI project also led to the development of an improved documentation method at the partnering institution. Anesthesia led treatment of corneal abrasions, as opposed to ophthalmology management, has been demonstrated to reduce the time to treatment. The improvement in CRNA perceived confidence in ability to treat corneal abrasions could lead to faster PACU discharge, decreased operating room delays and the cost associated with each.

Keywords: corneal abrasion, anesthesia, CRNA, reference guide, educational intervention

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Section I. Introduction

Background

The American Society of Anesthesiologists (ASA) recognizes that surgical anesthesia is safer today than it has ever been but emphasizes that it is not without inherent risk (n.d.). Postoperative complications of anesthesia are most often mild but can be severe, including postoperative cognitive dysfunction, cardiovascular and pulmonary complications, malignant hyperthermia, permanent nerve injuries, and death. Ocular injuries from anesthesia are rare, with an incidence of 0.056% overall to as high as 0.2% in spinal surgeries (Yu et al., 2010). Ocular injuries can be as severe as permanent vision loss (Singh et al., 2021). However, most often they are mild and limited to temporary irritation like corneal abrasions (CAs), which heal within 72 hours (Malafa et al., 2016).

The leading cause of postoperative vision loss, ischemic optic neuropathy, is very rare, with an incidence of 0.00054% (Singh et al., 2021). Vision loss occurs from infarction of the optic nerve as a consequence of inadequate oxygen delivery. Ischemic optic neuropathy can occur from prolonged hypotension, anemia, elevated cerebrospinal fluid pressure, ocular compression from edema, and prolonged Trendelenburg positioning. Elevated intraocular pressure (IOP) can contribute to vision loss if it is greater than the perfusion pressure of the central retinal artery. Succinylcholine is known to elevate IOP due to depolarization of ocular muscles, leading to a reduction in aqueous humor drainage. The anesthetic gas nitrous oxide (N_2O) can expand closed air spaces due to its increased solubility which leads to expansion of intraocular gases used during retinal surgery such as sulfur hexafluoride (SF_6) and perfluoropropane (C_3F_8) leading to elevated IOP.

The most common ocular complication of non-ocular surgery is CA, which does not often lead to the devastating loss of vision seen with ischemic optic neuropathy (Malafa et al., 2016). CA occurs when the epithelial layer of the cornea is removed from the basement membrane and can be caused by foreign body or chemical trauma (Moos & Lind, 2006). General anesthesia impairs normal protective mechanisms predisposing the cornea to injury. Loss of protective mechanisms leads to corneal drying, making the surface more vulnerable to sources of mechanical trauma during surgery. The incidence of CA has been reported as high as 0.64% (Papp et al., 2019), but Deljou et al. (2019) suggest the incidence of CAs could be grossly underestimated when relying on incident reports. They found a higher incidence when cases were identified based on the administration of local anesthetic for the treatment of CAs rather than incident reporting alone, which could be inadequate due to provider apprehension regarding adverse outcome reporting.

Pathophysiology and Mechanism of Injury for Perioperative Corneal Abrasions

The cornea is the most richly innervated tissue in the body and contains free nerve endings that are not covered by an epithelial surface, making the cornea very sensitive to external stimuli (Malafa et al., 2016). Numerous protective mechanisms exist to protect the corneal surface from injury. The tear film layer is a protective surface that is constantly renewed and is composed of three layers: an aqueous, a mucin, and an outer lipid layer. The aqueous and mucous layers irrigate debris and provide immune defense. The lipid component, released during blinking, functions as a lubricant, and prevents evaporation of the aqueous layer to prevent drying of the corneal surface. The tear film layer is also the source of dissolved oxygen supply because the cornea is avascular. Closure of the eyelids protects the cornea and acts to renew the tear film layer. An additional protective mechanism is Bell's phenomenon which, in an effort to

better protect the cornea, mechanically rotates the globe of the eye upwards under the upper lid when the eyes are closed.

General anesthesia impairs the protective mechanisms of the cornea, placing patients at risk for corneal injury (Malafa et al., 2016). General anesthetics suppress autonomic reflexes interrupting the production of the tear film layer, reflex tearing, and Bell's phenomenon. The blink reflex is important in regenerating the tear film layer and is abolished during general anesthesia (Moos & Lind, 2006). Lagophthalmos, incomplete closure of the eyelid, occurs in as many as 60% of patients while under general anesthesia, diminishing tear production, exposing the cornea to the exterior environment, and promoting corneal drying (Malafa et al., 2016). With the lack of tear film layer, corneal edema and drying can lead to increased friction on the corneal surface, making the cornea more vulnerable to mechanical trauma and CA. The lack of corneal protection under general anesthesia makes the cornea vulnerable to injury from exposure, pressure on the globe, and chemical and mechanical trauma (Moos & Lind, 2006).

During and immediately after surgical procedures, direct trauma to the cornea can occur from oxygen face masks, laryngoscopes, surgical drapes and instrumentation, or even inadvertent rubbing of the eyes with a finger, especially with a pulse oximeter placed on the patient's finger (Malafa et al., 2016). Chemical trauma can also occur as a result of irritation from volatile anesthetics, ocular lubricants used for protection, and sterilizing chemicals used during preparation of the surgical site if spilled into the eye (Moos & Lind, 2006). Although corneal abrasions typically heal within 72 hours, patients are predisposed to infection (Malafa et al., 2016). Also, during the first 24 hours they can experience intense pain, photophobia, and blurry vision, which can affect patient satisfaction and PACU discharge (Papp et al., 2019).

It is recommended that all patients have eyelids closed with a strip of tape immediately after induction of anesthesia (Malafa et al., 2016). If patients are identified to be at increased risk for CAs, transparent bio-occlusive dressings can be utilized for further protection. Ocular lubricants can also be used to act as an artificial tear film layer to help prevent the loss of this protective mechanism during anesthesia (Grixti et al., 2013). However, a high degree of variability in perceived importance and inconsistent use of eye protection strategies has been observed (Vetter et al., 2012). Recommendations for perioperative eye care discussed in the current literature are highly variable and many treatment guidelines are outdated (Malafa et la., 2016). Despite the risk of CAs during surgical procedures, and with CAs accounting for 35% of ocular injuries in ASA closed claim analyses, many institutions lack a specific standard of care or protocol for prevention. In their case-control study, Carniciu et al. (2017), found their institution had no standard protocol for eye protection, as well as a lack of documentation of eye-protective strategies used during surgical cases.

The American Association of Nurse Anesthetists (AANA) Standards for Nurse Anesthesia Practice requires Certified Registered Nurse Anesthetists (CRNAs) to monitor the patient's position during surgery to prevent injury and to monitor and document the patient's physiologic condition (n.d.). However, they do not provide specific guidance on preventing perioperative CAs.

Organizational Needs Statement

The partnering organization for this quality improvement pilot project does not have a standard protocol for the prevention of perioperative CAs (M. S. McAuliffe, personal communication, September 14, 2021). Prevention practices, as in most hospitals, are left to the discretion of the individual anesthesia provider and their practices can be highly variable. The

confusion amongst best practice, outdated guidelines in the literature, and lack of institutional or organizational protocols of care may contribute to confusion and inconsistent care among providers as they attempt to protect their patients from CAs. Additionally, documentation of eye protection at the partnering institution only allows the provider to select that the eyes were protected with clear tape prior to laryngoscopy as a part of the airway note. If the anesthesia provider chooses to use additional prevention measures during the case, this must be documented as a narrative note. The process can be time consuming and could cause a lack of documentation of additional eye protection measures utilized.

It has been demonstrated that simple educational initiatives about the prevention of CAs, in combination with standardized prevention and treatment protocols, have been effective in reducing perioperative CAs (Ely et al., 2019; Lichter et al., 2015; Martin et al., 2009; Vetter et al., 2012). In light of the lack of a recommended standard of care from the anesthesia community, such as the AANA or American Society of Anesthesiologists (ASA), and the lack of a standardized protocol at the partnering institution, a CA quick reference guide was developed for CRNAs at the partnering institution to help them prevent CAs in their practice.

The Institute for Healthcare Improvement (n.d.-b) has developed a framework called the Triple Aim in order to optimize healthcare performance. The framework seeks to improve patient care quality and satisfaction, improve the health of populations, and reduce the cost of healthcare. Perioperative CAs can negatively impact patient satisfaction and quality of care and delay discharge from the post anesthesia care unit (Papp et al., 2019) potentially leading to increased cost. Additionally, awards for patients experiencing ocular injuries during surgery are 4% higher than other claims. This quality improvement project addressed each of the three

dimensions of the Triple Aim by focusing on the prevention of perioperative CAs through assessment and support for evidenced based practice by CRNAs at the partnering institution.

Problem Statement

Perioperative corneal abrasions are the most common type of ocular injuries reported in non-ocular surgery, with an incidence of 0.64 % (Papp et al., 2019). Like most institutions, the partnering facility lacked a standardized approach to eye care during general anesthesia.

Purpose Statement

The purpose of this quality improvement project was to assess CRNAs' preferences and practices regarding eye care and CA prevention and whether or not they perceived the CA quick reference guide as a useful tool for their practice to prevent and treat CAs.

Section II. Evidence

Description of Search Strategies

The purpose of this literature review was to examine current evidence and recommendations regarding CA prevention and identify the effectiveness of quality improvement initiatives related to preventing CA. The PICOT question used to guide the search strategy was: How do CRNAs perceive a quick reference handout designed to increase awareness and prevent corneal abrasions in the operating room and perioperative period? Major concepts identified included corneal abrasions, operating rooms, and CRNAs. See Appendix A for a complete list of keywords, MeSH headings, and subject terms utilized in searches.

A search of current literature was conducted using the databases PubMed and Cumulative Index to Nursing and Allied Health Literature (CINAHL) as well as the search engine Google Scholar. Boolean operators were used to combine keywords and concepts. The search strategy used to query PubMed was (surgery OR surgical procedures OR perioperative OR operating rooms) AND (corneal injuries OR corneal abrasions OR eye injury OR ocular injury) AND (nurse anesthetists OR nurse anaesthetists OR anesthesia OR anaesthesia OR anesthesiology OR anesthesiologist). This search strategy pulled in the MeSH terms *surgery, surgical procedures, operative, general surgery, operation rooms, cornea, corneal injuries, eye injuries, nurse anesthetists, anesthetists, anesthesia, anesthesiology,* and *anesthesiologists*. Limits applied included publication between 2009 and 2021 and English language. CINAHL was searched using a combination of keywords and subject headings identified using the same keywords from the PubMed Search. Major headings were *corneal injuries, eye injuries, operating rooms, surgery, operative, intraoperative period, intraoperative care, intraoperative complications, intraoperative monitoring, nurse anesthetists, anesthesia, anesthesia recovery, anesthesiology,* and *anesthesiologists*. Google Scholar was searched using the same strategy as PubMed. See

Appendix A for concepts, keywords, and search strategies. See Appendix B for search strategies and numbers of articles found and kept using structured searching. Additional evidence was identified by reviewing related and referenced articles as well as websites and resources of anesthesia organizations.

Initially, items were screened for pertinence to the project through title and abstract review. A total of 34 articles were identified as potentially pertinent to this project based on their mention of incidence, risk factors, prevention, diagnosis, treatment, performance improvement programs, prevention protocols, and educational initiatives related to CA. These articles were saved to RefWorks and, upon full-text review, a total of 12 were deemed pertinent to this project. Based on Melnyk and Fineout-Overholt's (2019) levels of evidence hierarchy, evidence identified included two systematic reviews (Level I), one observational study (Level IV), four retrospective case-control studies (Level V), two quality improvement studies (Level VI), and two expert opinion reviews (Level VII). Review of related articles and references identified one additional quality improvement initiative (Level VI). Refer to Appendix C for a complete literature matrix outlining the findings from each source.

Selected Literature Synthesis

Risk Factors of Perioperative Corneal Abrasions

Kaye et al. (2019) emphasized the key to preventing CAs is to first identify patients at high risk, as patient demographics and co-morbid conditions can increase the risk of perioperative CAs occurring. Advanced age is the most common risk factor for CA reported in the literature (Kaye et al., 2019; Lichter et al., 2015; Malafa et al., 2016; Segal et al., 2014) because tear film lipid layer composition decreases with age and predisposes the cornea to injury (Papp et al., 2019). In their observational study including over 90,000 surgical cases, Lichter et

al. (2015) identified a mean age of 64 years in patients diagnosed with perioperative CA compared to a mean age of 58 years in patients not diagnosed with a CA. Diabetes has been associated with a higher risk of CA in some studies (Grixti et al., 2013) citing decreased tear production and decreased corneal sensitivity to external stimuli, while no association has been determined in others (Carniciu et al., 2017). Additionally, in a retrospective case controlled study involving 37 cases of CA and 110 controls, Carniciu et al. found patients with pre-existing ocular disease 3.6 times more likely to experience CAs than those without, and 16.7 times more likely to experience CAs when undergoing procedures lasting more than 3 hours. Pre-existing ocular diseases associated with perioperative CA include chronic dry eye (Kaye et al., 2019; Malafa et al., 2016; Segal et al., 2014), cataracts, and glaucoma (Segal et al., 2014). Graves' disease (Martin et al., 2009) and exophthalmos (Kaye et al., 2019; Malafa et al., 2016) have also been shown to increase the risk of CA, likely due to the prominence of the globe and inability to achieve adequate eyelid closure (Malafa et al., 2016).

Many risk factors for CAs are inherently related to surgical duration and techniques required for specific surgeries. Prolonged surgical time and patient positioning in the lateral, prone, or Trendelenburg position are two of the most common risk factors reported (Carniciu et al., 2017; Grixti et al., 2013; Kaye et al., 2019; Lichter et al., 2015; Malafa et al., 2016; Martin et al., 2009; Segal et al. 2014; Yu et al., 2010). A study by Segal et al. (2014) found that average surgical time was 3.85 hours versus 1.7 hours respectively when comparing 86 cases of CA to 89 cases where CA did not occur. Additionally, Carniciu et al. (2017) compared 37 cases where CA occurred to 101 cases where no CA occurred and found that patients are 4.6 times more likely to experience CA with procedures lasting more than 3 hours than procedures lasting less than 3 hours. Prolonged surgery lengthens the time of diminished protective mechanisms and tear film

layer decreases over time, placing patients at greater risk (Malafa et al., 2016). Patient positioning in the lateral, prone, and Trendelenburg position can place the eye in a dependent position increasing intraocular and venous pressure leading to edema (Sampat et al., 2015). Edema makes the cornea more vulnerable to injury from lagophthalmos and lifts epithelial cells from the basement membrane making them more likely to separate with minimal force (Malafa et al., 2016). Additionally, deliberate intraoperative hypotension and preoperative anemia can predispose the cornea to ischemia and precipitate corneal edema (Grixti et al., 2013; Malafa et al., 2016; Yu et al., 2010).

CAs are commonly reported in some specific surgeries for various reasons. Surgeries involving instrumentation, such as robotic procedures, place patients at greater risk for CAs simply due to the increase in number of potential sources for mechanical trauma (Sampat et al., 2015; Segal et al., 2014). Urological surgeries are also associated with an increased risk of CAs, possibly due to the use of the Trendelenburg position combined with the increased instrumentation required. Sampat et al. (2015) studied laparoscopic and open hysterectomy cases and found a 4 times higher risk for CA in laparoscopic hysterectomy compared to open hysterectomy. Furthermore, a 7 times greater risk was observed when robotic assistance was used for hysterectomy. They also found an incidence of 0.18% in robotic prostatectomy cases. Additionally, surgery in the head and neck area places the cornea in a vulnerable position within the operative field and is commonly mentioned as a risk factor for CA (Carniciu et al., 2017; Grixti et al., 2013; Kaye et al., 2019; Malafa et al., 2016; Martin et al, 2009). In their retrospective case-control study involving over 100,000 non-ocular surgeries, Martin et al. (2009) identified that of patients suffering from CA, 15.4% had surgery in the head or neck area while only 9% of patients not experiencing CA had surgery in the head or neck area. Surgery in

the head and neck area often precludes taping of the eyelids, making the cornea more likely to be injured from instrumentation in the surgical field or spilled surgical preparation chemicals into the eye (Yu et al., 2010).

Often, risk factors for CA are directly related to anesthesia equipment and the need for the anesthesia team to manipulate equipment near the patient's eyes. Many of these risk factors are under the direct control of the anesthetist. Damage to the cornea from equipment such as identification badges, stethoscopes, watch bands, laryngoscopes, oxygen face masks, pulse oximeters, surgical drapes, and intraoperative warming blankets are commonly reported (Grixti et al, 2013; Kaye et al., 2019; Malafa et al., 2016). Accidental trauma to the cornea can be caused by the anesthetist's equipment, hands, and fingernails during laryngoscopy and intubation (Kaye et al., 2019). Many patients rub their eyes on emergence from anesthesia, making a pulse oximeter probe placed on a finger of the patient's dominant hand a likely source for CA. Interestingly, anesthesia provided by a Student Registered Nurse Anesthetist (SRNA) has been correlated with a high incidence of CA (Grixti et al., 2013). In their case-control study evaluating 117 cases of CA, Martin et al. (2009) identified a 39.3% incidence of CAs when an SRNA was present at the start of surgery. To minimize the risk of CA, vigilance on the part of the supervising nurse anesthetist is important when anesthesia is being provided by a SRNA.

Strategies for Prevention of Perioperative Corneal Abrasions

Many methods for CA prevention have been explored in the literature, with most evidence showing that some form of ocular protection significantly decreases the risk. Malafa et al. (2016) recommended that all patients have their eyelids closed immediately after induction of anesthesia but before intubation, recognizing that simple eyelid taping is often effective. In one systematic review of older literature that identified eight randomized controlled trials and one

historical controlled study, Grixti et al. (2013) recognized that simple closure of the eyelids with tape is one of the most popular methods of prevention, and recommended horizontal as opposed to vertical lid taping to achieve complete closure of the eyelids. It has been shown that 90% of CAs occur when no form of ocular protection is utilized, while simple manual closure of the eyelids without taping decreased the occurrence to 59% of CAs (Papp et al., 2019). In addition to manual closure, eyelid taping or use of bio-occlusive dressing, such as Tegaderm, reduced the incidence to 0.2% and 0.02% respectively.

A retrospective case-control study by Yu et al. (2010) identified only 10 CAs from 75,000 surgical cases, an incidence of only 0.0001%, at their institution, which implements simple taping of the eyelids for all cases and Tegaderm dressings for high risk operations such as long duration, surgery in the head or neck area, and lateral, prone, or Trendelenburg positioning. Papp et al. (2019) identified Tegaderm as the most popular strategy used, and multiple simple and systematic reviews recommend the use of Tegaderm in high risk cases (Grixti et al., 2013; Malafa et al., 2016; Papp et al., 2019; Kaye et al., 2019). Tegaderm can cover the entire eyelid, promoting strong closure and creating an air-tight seal, which may be more effective in preserving the tear film layer during long cases and preventing chemical trauma from spillage of sterilizing solutions into the eye (Kaye et al., 2019; Malafa et al., 2016). Additionally, it is recommended that tape be removed prior to emergence from anesthesia in a top to bottom fashion to avoid opening of the upper eyelid (Kaye et al., 2019).

Simple taping of the eyelids does not correct the decreased tear secretion and destruction of the tear film layer associated with anesthesia. Ocular lubricants have been proposed as an intervention to replace the deficient tear film layer during anesthesia, with literature suggesting a preference for fat-based ointments over aqueous solutions (Grixti et al., 2013). Paraffin based

ointments have been associated with blurry vision and local allergic reactions (Grixti et al., 2013). They are also flammable, limiting their use with high oxygen concentrations and electrocautery sources near the head or neck (Kaye et al., 2019; Malafa et al., 2016). Paraffin ointments are petroleum based and more soluble anesthetics such as halothane and isoflurane can become solubilized in the ointment and irritate the eyes. Methylcellulose solution has been recommended as the most effective lubricant as it lowers risk of irritation (Grixti et al., 2013) and promotes strong contact between upper and lower eyelids to support closure and prevent tear film evaporation (Malafa et al., 2016). Solutions containing preservatives are known to cause chemical injury as a result of sloughing of the corneal epithelium and should be avoided (Grixti et al., 2013; Malafa et al., 2016). It is recommended that if taping of the eyelids is contraindicated due to surgical necessity, eye lubricants be used in place of taping (Malafa et al., 2016). Some new dressings combine closure and lubrication of the eyelid. Hydrogel dressings contain a gel substance and are transparent, allowing for direct visualization of the eye during surgery, but can cause CAs if the gel is allowed to dry (Grixti et al., 2013).

Additional strategies for prevention of CA include minimizing the potential causes during induction and emergence from anesthesia. Kaye et al. (2019) called on providers to be aware of their materials and equipment that may cause CA such as stethoscopes, badges, and watch bands. They also recommended securing items like bedding and oxygen tubing away from the patient during transport to the post anesthesia care unit. Thoughtful placement of the pulse oximeter probe on the patient's non-dominant hand can also prevent inadvertent scratching of the cornea if the patient rubs their eyes during emergence.

Treatment of Perioperative Corneal Abrasions

It is important for anesthesia providers to be aware of treatment strategies for CA should they occur. Treatment of CA should focus on alleviating pain and preventing infection (Kaye et al., 2019). In the past, it was thought that topical anesthetics were associated with delayed healing of CA, but newer research has demonstrated the opposite. The use of 1% tetracaine or 0.1-0.5% proparacaine has been recommended, with use limited to the first 24 hours of treatment to prevent masking of pain associated with a worsening condition (Kaye et al., 2019; Malafa et al., 2016). Topical non-steroidal anti-inflammatory drugs (NSAIDs) can also be used to treat pain but should be limited to 24-48 hours as they could cause corneal toxicity. Additionally, cycloplegics such as cyclopentolate and homatropine inhibit pupillary dilation and can be used to prevent pain associated with corneal movement in patients with large CAs (Kaye et al., 2019).

Prevention of infection is important as untreated and worsening infection could lead to permanent blindness (Kaye et al., 2019). The most commonly used antibiotic is 0.5% erythromycin ointment (Kaye et al., 2019; Malafa et al., 2016). Patients who wear contacts are more susceptible to gram negative pseudomonas infections and should be treated with antibiotics such as ofloxacin, moxifloxacin, or gentamicin. Lichter et al. (2015) developed an anesthesiology-led protocol to treat CAs utilizing 0.5% erythromycin ointment and Refresh artificial tears to lubricate the cornea and decrease pain. They successfully treated 93% of patients diagnosed with CA without an ophthalmology consult.

CAs are commonly associated with very intense pain (Malafa et al., 2016) and prompt treatment is necessary. However, studies have identified that time to patient complaint of symptoms can be as long as 129 minutes, followed by an additional 162 minutes before ophthalmology consult (Segal et al., 2014). This delay results in patients remaining in discomfort

without treatment for almost 5 hours. Segal et al. recognized that treatment recommendations from ophthalmologists were frequently very simple and could be performed by the anesthesiology team. They developed and recommended the use of a treatment algorithm for anesthesiology to follow. Lichter et al. (2015), as previously mentioned, utilized a similar anesthesiology-led treatment algorithm with artificial tears and erythromycin ointment. They were able to achieve a mean time to treatment of 177 minutes by avoiding the need to wait for an ophthalmology consult. The protocol significantly limited the time patients were without appropriate treatment while also achieving resolution of symptoms of all patients within 24 hours. Despite supporting anesthesiology's ability to treat CAs effectively, both studies recommended limiting treatment to 24 hours and referring to ophthalmology for further management if symptoms persisted.

Improving the Prevention and Management of Corneal Abrasions

Due to the lack of a specific standard of practice for prevention of corneal abrasions, documentation of prevention measures used (Carniciu et al., 2017), and inconsistent use and appreciation of the importance of prevention practices (Vetter et al., 2012), there is a need for quality improvement initiatives addressing CA prevention. Carniciu et al. (2017) recommended institutions develop their own CA prevention protocols, educational initiatives, and required documentation of prevention strategies used. It has been recognized that simple educational programs, prevention, and treatment protocols have been effective in improving the incidence and treatment of CAs (Ely et al., 2019; Lichter et al., 2015; Martin et al., 2009; Vetter et al., 2012). Further, it has been shown that anesthesiology departments are capable of treating simple CAs, limiting the delay in PACU discharge often seen with ophthalmology-led treatment (Lichter et al., 2015).

Vetter et al. (2012) noticed an increase in CAs at their institution and observed highly variable prevention practices and appreciation of the importance of these prevention practices amongst providers. They implemented a protocol for the anesthesia department along with a documentation shortcut, educational presentations to staff, and online access to eye protection protocols. Overall, they were able to decrease the incidence of CAs from 1.2 cases per 1000 to 0.09 per 1000 surgeries. Additionally, documentation compliance increased from 3.4% to 74.9%. They were able to sustain improvement for a 45 month follow up period and estimated cost savings of $637 per corneal injury prevented. Ely et al. (2019) used a similar educational initiative and prevention algorithm showing improvement in the incidence of CA from 0.37% to 0.19% at their institution. Martin et al. (2009) showed a step-wise decrease in CA incidence at their institution. The department of anesthesiology implemented an email notification to providers involved in the care of patients who sustained a CA and decreased the incidence from 1.51 per 1000 surgeries to 1.37 per 1000 surgeries. The department demonstrated a further decrease to 0.79 per 1000 surgeries after a lecture, presented by ophthalmologists to anesthesia department staff, focusing on risk factors and prevention utilizing simple taping of the eyelids after induction and prior to intubation. They continued to show improvement over a 15 month follow up period with incidence decreasing to 0.47 per 1000 surgeries. The authors determined an increase in provider awareness in combination with education accounted for the improvement.

Education of anesthesia providers regarding identification of patients at high risk for CA, effective prevention measures, and access to prevention algorithms have clearly been effective in reducing the incidence of CA. Should a CA occur, anesthesiology departments have been successful in managing the treatment of simple CA without ophthalmology consult, expediting PACU discharge and improving patient satisfaction (Lichter et al., 2015). With the lack of

standardized protocols or recommendations from anesthesia regulatory bodies such as the AANA or ASA, individual institutions can initiate quality improvement programs to improve prevention and management of CA.

Project Framework

This project used the model for improvement from the Institute for Healthcare Improvement and implemented a single plan-do-study-act cycle (n.d.-a). The plan-do-study-act (PDSA) cycle involves testing a change on a small scale, measuring the effectiveness of the change, evaluating what was successful or unsuccessful, and acting on the results. Prior to beginning, it is important to identify what to accomplish, how an improvement will be measured, and what change can be made leading to the improvement (Connelly, 2021). The change is then planned, implemented on a small scale, results studied, and improvements made. The model is useful for quality improvement because of the ability to learn what works quickly in a particular setting and make needed adjustments. PDSA cycles can then be repeated based on what was learned in order to sustain the improvement. The PDSA cycle was applied in this project by planning an intervention based on the selected literature review. The intervention was carried out with a pre/post-survey to study its effectiveness. What was learned from the study could then be modified in order to implement another PDSA cycle to allow for continued improvement.

Ethical Considerations and Protection of Human Subjects

The benefits and risks of the intervention applied equitably to everyone included in the target population, there was no more than usual risk of harm to participants, and all activities fell within accepted practice protocols. In order to prepare for project approval, Collaborative Institutional Training Initiative (CITI) Program modules related to the responsible conduct of research were completed by the primary investigator (https://about.citiprogram.org/). An

approval process was first completed through the East Carolina University College of Nursing in conjunction with the East Carolina University and Medical Center Institutional Research Board (UMCIRB) which determined the project was quality improvement and not subject to full IRB review. Approval was additionally obtained through the research office of the partnering institution in collaboration with the East Carolina UMCIRB. There was no patient data or information collected for use during the implementation of this quality improvement project. See Appendix D.

Section III. Project Design

Project Setting

This project was implemented in the operating suite of a large academic medical center during surgical cases involving spinal surgery. The medical center, Department of Anesthesia, and Nurse Anesthesia Program have a long-standing relationship that facilitated collaboration on the project. The academic nature of the medical center provided for a friendly environment for project implementation.

Project Population

The project was implemented with five CRNAs providing anesthesia to patients undergoing spinal surgery at the institution. Spinal surgery often necessitates prone positioning, which is known to place patients at higher risk for CA. In a study analyzing over 75,000 cases of non-ocular surgery, Yu et al. (2010) determined the incidence of ocular injuries in spinal surgeries to be 0.2%. Spinal surgery at the partnering institution typically occurs in 2 to 3 operating rooms each day with each room averaging 3-4 cases per day for a total volume of 6 to 12 spinal surgeries daily. Provider apprehension to change, long established practices regarding CA prevention, and productivity pressure were anticipated barriers to project implementation.

Project Team

The project team consisted of an SRNA team lead who worked in collaboration with three additional SRNA team members, three faculty members, and a clinical CRNA. The team worked together to develop the intervention and the pre- and post-intervention surveys for data collection within the various settings and populations assigned. Each SRNA team member was assigned a different setting and population for independent project implementation, data collection, and analysis. The project chair initiated contact with the partnering institution, served

as an expert advisor for the project team, and gave final approval for all project details. The chair communicated with the clinical faculty member who identified CRNAs willing to participate in the project and facilitated collaboration between participating CRNAs and the project team lead. The clinical CRNA signed a letter of acknowledgement that data would be collected in the operating room. The CRNA program director served as the project chair. The course director acted as an educational resource for the development of this quality improvement project, literature review process, the writing of this paper, and project implementation.

Methods and Measurement

The purpose of this quality improvement project was to assess CRNAs' preferences and practices regarding perioperative eye care and CA prevention and whether or not they perceived a CA quick reference guide (See Appendix E) as a useful tool in their practice. A single PDSA cycle, as in the Institute for Healthcare Improvement model for improvement, was used to implement the project. The primary goal of the project was to provide access to a quick reference guide regarding prevention and treatment of CAs and to assess CRNAs' perceived adequacy of the use of the newly developed tool. Secondary goals of the project included assessing CRNAs' current preferences and practices in prevention of CAs, identification of patients at high risk for CA, diagnosis and treatment of CAs, and their personal involvement in the care of patients with an identified perioperative CA.

The plan portion of the PDSA cycle involved monthly meetings between the SRNA team members, project chair, course director, and program director. Meetings served as opportunities for group collaboration regarding the development of the intervention and data collection methods. SRNA team members worked together during the plan portion to develop a CA quick reference guide, pre-intervention survey, post-intervention survey, PowerPoint presentation, and

email distributions. Meetings also provided an opportunity for the project chair to review the plan for the intervention and data collection methods, provide constructive feedback, and approve final versions.

The do portion of the PDSA cycle began after final approval from the East Carolina UMCIRB and the partnering institution. The clinical faculty member recruited the target population of five participating CRNAs providing anesthesia in the setting of spinal surgeries at the academic medical center. CRNAs were surveyed prior to implementation of the intervention regarding their practice related to prevention and treatment of perioperative CAs. Pre-intervention survey questions were developed by the project team in order to obtain a baseline understanding of current knowledge, preferences, and practices of CRNAs participating in the project. These pre-intervention survey questions (seen in Appendix F) were entered into Qualtrics and used to create a Qualtrics survey after final approval by the project chair. The pre-intervention survey was then distributed to email addresses provided by participating CRNAs two days prior to implementation of the intervention. CRNAs were instructed to complete the pre-intervention survey prior to viewing the PowerPoint presentation and CA quick reference guide attached to the pre-intervention email.

Due to the lack of a published national standard of care, a new CA quick reference guide was developed by the project team to serve as a quick access resource for CRNAs. The PowerPoint presentation (seen in Appendix H) was created by the project team outlining the use of the CA quick reference guide. In the event they preferred to have access to a hard copy of the CA quick reference guide, CRNAs were also provided with a laminated copy of the guide.

As seen in Appendix E, the guide included information about incidence, risk factors, sources, pathophysiology, assessment, diagnosis, prevention methods, and a treatment protocol

for CAs. The reference guide was developed based on the aforementioned review of current literature and recommendations synthesized from each source. A treatment algorithm was developed based on findings from the same literature review regarding current recommendations for the treatment of CAs, which were synthesized for use by providers. Participating CRNAs were asked to view the PowerPoint presentation and utilize the CA quick reference guide for two weeks while providing anesthesia to their patients. A reminder email to complete the pre-intervention survey and view the PowerPoint presentation and CA quick reference guide was sent to participating CRNAs at the end of the first week of implementation.

The final part of the do portion of the PDSA cycle involved surveying participating CRNAs regarding their use of the CA quick reference guide over the two week implementation period. Post-intervention survey questions were developed by the project team in order to assess CRNAs' use of the reference guide and their perceived adequacy of its use to prevent and treat perioperative CAs. The post-intervention survey questions were used to create a Qualtrics survey after final approval by the project chair. The post-intervention survey was then distributed to email addresses provided by participating CRNAs and is presented in Appendix F. Pre- and post-intervention questions included nominal, ordinal, and ratio levels of measurement. The project team lead was immediately available in the setting during the two week implementation period to act as a resource for participating CRNAs. All email communications can be seen in Appendix G.

Data was collected using Qualtrics and analyzed using Excel. Pre- and post-intervention survey questions were used to evaluate the effectiveness of the intervention as part of the study portion of the PDSA methodology. Outcome measures included improvement in provider awareness, confidence in their ability to prevent, diagnose, and treat CAs, and their perceptions

regarding the adequacy of the use of the reference handout. Outcome measures and perceived barriers recorded by participating CRNAs were studied in order to identify changes that could be implemented in future PDSA cycles. As part of the act portion of the PDSA cycle, the analyzed results of the project were shared with faculty and students in the nurse anesthesia program as well as participants from the partnering organization. Additionally, this paper was posted to The Scholarship, ECU's digital repository.

Section IV. Results and Findings

Results

The purpose of this quality improvement project was to assess CRNAs' preferences and practices regarding eye care and CA prevention and treatment and whether or not they perceived a corneal abrasion quick reference guide as a useful tool for their practice. A review of current literature was conducted, and a CA quick reference guide developed. The CA quick reference guide focused on reiteration of causes of CAs, pathophysiology of CAs, surgical and patient risk factors for CAs, and current recommendations for prevention of CAs. Additionally, a synthesis of current recommendations for the treatment of CAs was performed and a new treatment algorithm developed for use by anesthesia providers.

Potential project participants at the partnering institution were recruited by a clinical faculty member of the nurse anesthesia program. Those agreeing to participate were emailed a link to a Qualtrics pre-intervention survey, PowerPoint presentation regarding the use of the CA quick reference guide, and electronic access to the CA quick reference guide for use in the clinical setting. Participants were asked to complete the pre-intervention survey via Qualtrics to ascertain their current clinical practice to prevent CAs, identify patients at high risk for CAs, and to diagnose and treat potential CAs. They were then asked to view the PowerPoint presentation and utilize the CA quick reference guide for two weeks during their anesthesia practice for spinal surgery. After the two week implementation period, participants were asked to complete a post-intervention survey via Qualtrics to assess their perception of the adequacy of the CA prevention guide, determine if any changes to their practice were made as a result of its use, and whether or not they perceived an increase in their perceived confidence to identify patients at high risk for CAs and to prevent CAs.

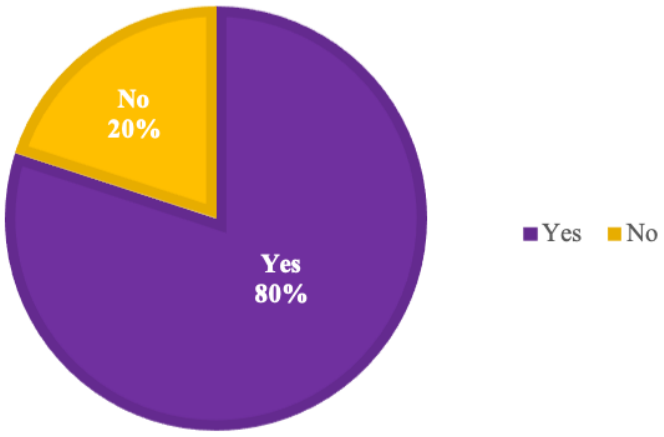
Survey questions contained nominal, ordinal, and ratio level measurements. There were five participating CRNAs, with five pre-intervention survey responses and five post-intervention survey responses received. Data collected from pre- and post-intervention surveys were analyzed using Excel. Graphs and figures for displaying relevant data were also created using Excel.

Data Presentation

As seen in Figure 1, four out of five CRNAs surveyed pre-intervention indicated that either they or an anesthesia provider they know had previously been involved in the care of a patient who sustained a perioperative CA. Of these four CRNAs, two indicated the CA occurred from the patient rubbing their eyes upon emergence from general anesthesia. One CRNA reported that manual trauma from equipment such as a stethoscope, identification badge, pulse oximeter probe, surgical drape, or robotic surgical equipment was the cause of the CA. Two CRNAs indicated the cause of the CA was unknown.

Figure 1

Involvement in the Care of a Patient with a CA

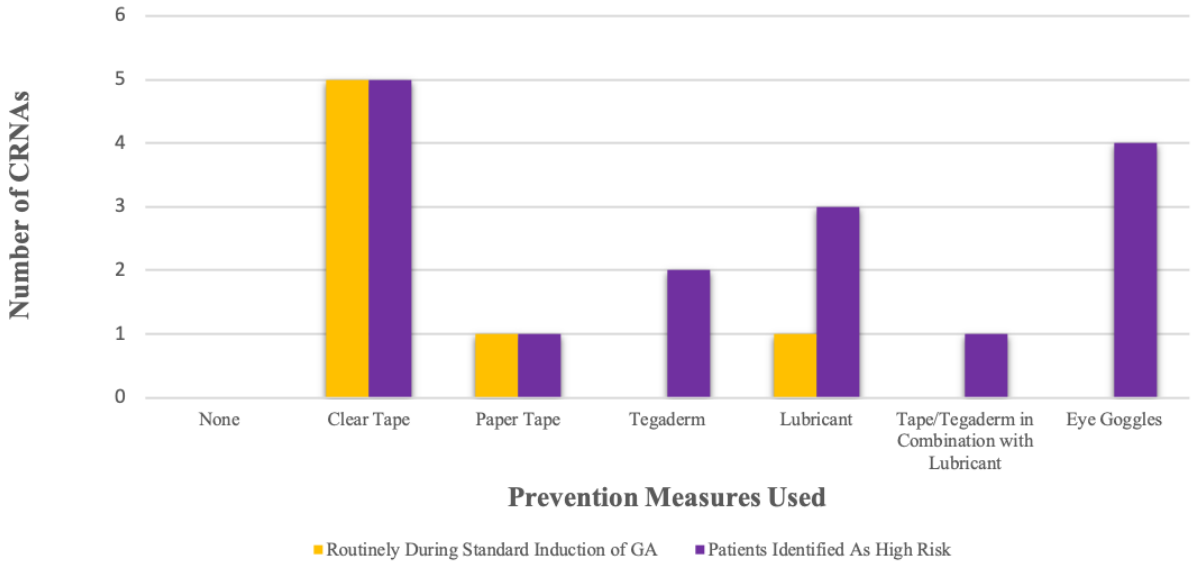


Note. N = 5. CA = Corneal Abrasion. Involvement could indicate direct involvement with a sustained CA or the knowledge of a colleague who was directly involved with a CA.

CRNAs in our project identified robotic surgery, coronary artery bypass grafting (CABG), neurosurgery, spinal, craniotomies, shoulder, and ear, nose, and throat (ENT) surgeries as high risk cases for perioperative CAs to occur. Additionally, one CRNA identified surgeries that require the surgeon to remove the protective measures used in order to gain access to the surgical site such as ENT, ophthalmic, and plastic surgery as high risk cases for CAs to occur. Four CRNAs out of five CRNAs surveyed indicated prone positioning as high risk for CAs to occur. Other positions identified as high risk included steep Trendelenburg, lateral decubitus, and sitting. Three out of five respondents indicated that they believe obese patients are at higher risk for perioperative CAs. Other comorbidities the CRNAs identified as high risk included older and younger patients, diabetes, and hyperthyroidism. Additionally, one CRNA responded that they believe patients with artificial eyelashes, nails, and makeup are at higher risk for CAs.

Figure 2

Method used to Secure the Eyes During Routine Induction of GA and in Patients at High Risk of CA



Note. N = 5. Multiple responses allowed. CA = Corneal Abrasion; CRNAs = Certified Registered Nurse Anesthetists; GA = General Anesthesia.

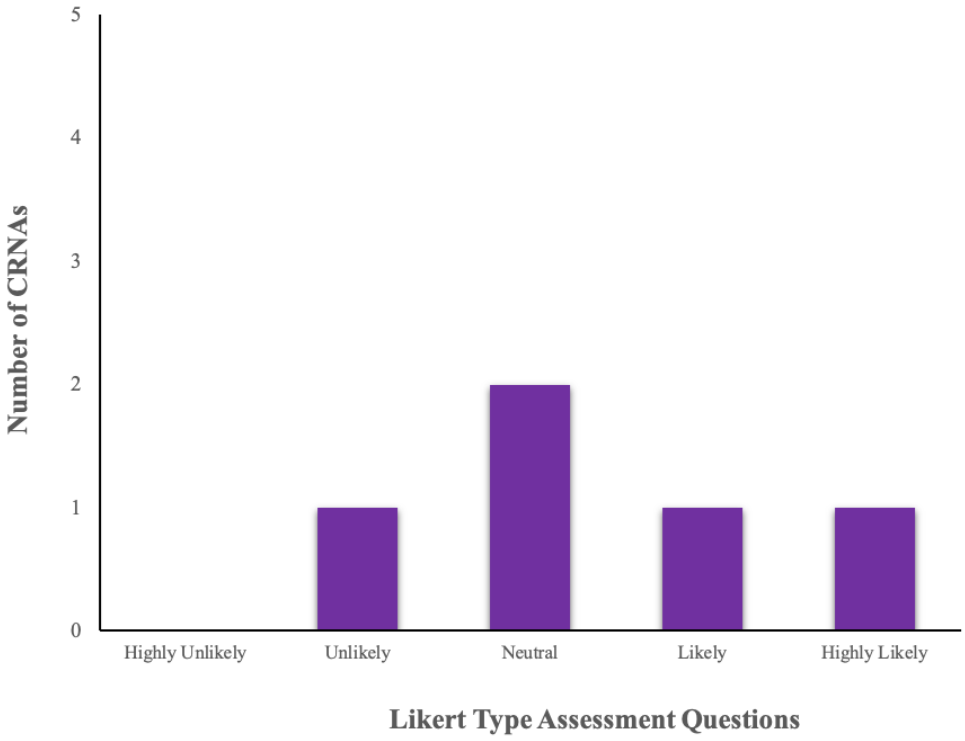
As illustrated in Figure 2, most CRNAs reported using either clear tape, paper tape, or eye lubricant during a standard induction of general anesthesia. All CRNAs indicated they taped the eyes immediately before securing the airway during a standard induction of general anesthesia. One CRNA indicated they assessed the eyes every 30 minutes, after position changes, and during emergence. One CRNA indicated that they assessed the eyes during position changes and during emergence. One CRNA reported they assessed the eyes every 15 minutes, one only during emergence, and one only after position changes. At least one participant reported implementing each of the following additional strategies in an effort to prevent CAs from occurring: placing the pulse oximeter probe on the non-dominant hand, additional vigilance during transport to the PACU to prevent the patient from rubbing their eyes, and being cognizant of cables and tubing when moving the patient from the operating room table to the stretcher. However, when CRNAs identified patients to be at high risk for CA, their practices to prevent CA in these patients were highly variable and included all prevention strategies listed in the survey.

In the post-intervention survey, all CRNAs indicated that they were not involved in a perioperative CA during the two week implementation period. Three CRNAs indicated they identified between 6 and 10 patients as high risk for CA and two indicated they identified between 1 and 5 patients as high risk for CA over the course of two weeks. One CRNA reported the CA quick reference guide was a useful reminder of surgical cases that were associated with a high incidence of CA and one CRNA said it was useful for guidance regarding CA prevention. However, three others believed the CA quick reference guide was not useful for their practice. As shown in Figure 3, responses regarding perceived likelihood of future use of the CA quick reference guide to prevent CAs were variable. One CRNA perceived that a barrier to the use of

the CA quick reference guide was that it was bulky in size. One CRNA commented that awareness of eye protection during transfer from the operating room to the PACU would be beneficial to include in the CA quick reference guide as a useful prevention measure. No CRNAs reported making changes to their current practice after implementation of the intervention, though three participants agreed or strongly agreed that the intervention increased their awareness of perioperative CAs. All five CRNAs felt that an Epic shortcut for eye care documentation would be beneficial to their practice.

Figure 3

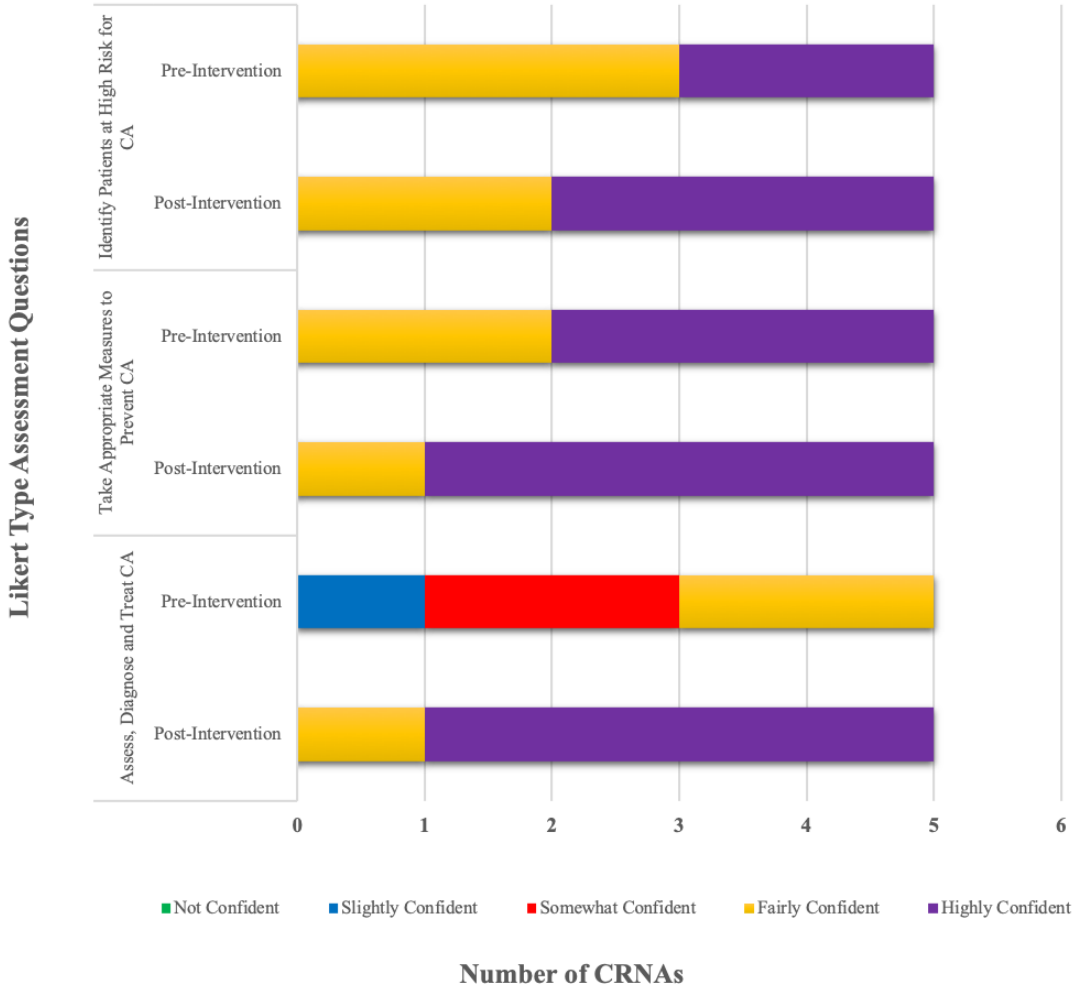
Liklihood to Utilize the CA Quick Reference Guide in the Future



Note. N = 5. CA = Corneal Abrasion; CRNAs = Certified Registered Nurse Anesthetists.

Figure 4

CRNA Perceived Confidence in Ability to Identify Patients at High Risk, Prevent, and Treat CAs



Note. N = 5. CA = Corneal Abrasion; CRNAs = Certified Registered Nurse Anesthetists.

Participating CRNAs were surveyed pre- and post-intervention regarding their confidence in their ability to identify patients at high risk for CAs, take appropriate measures to prevent CAs, and assess, diagnose, and treat CAs. Comparison of pre- and post-intervention results can be seen in Figure 4. Regarding perceived confidence in their ability to identify patients at high risk for CA, more than half of participating CRNAs were fairly confident pre-intervention which improved to more than half being highly confident post-intervention.

Although most CRNAs were highly confident pre-intervention, there was still an increase after the intervention in CRNAs' perceived confidence in their ability to take appropriate measures to prevent CA. More than half of participating CRNAs were only slightly or somewhat confident in their ability to assess, diagnose, and treat CAs pre-intervention, while after the intervention, all CRNAs reported being fairly or highly confident.

Analysis

In our small project at a single academic medical center, there was a high probability of a CRNA being involved in the care of a patient who sustained a perioperative CA at some point in their career. This emphasizes the importance that CRNAs be able to identify patients who are at high risk of CA, take appropriate measures to prevent CA, and have the knowledge and skills to diagnose and treat a CA should one occur. CRNAs in our project were consistent with the literature in their identification of patients who are at high risk for CAs either due to the specific nature of the surgery, surgical positioning, or patient co-morbidities. They were also confident pre-intervention in their ability to identify these patients, suggesting that CRNAs participating in our project had adequate knowledge regarding identification of patients who are at high risk for CAs. However, this project did demonstrate positive change post-intervention in CRNA perceived confidence in their ability to identify patients at high risk for CA. The improvement shown after our educational intervention suggests that continued education regarding perioperative CA prevention could maintain and even improve providers' ability to identify patients at high risk. Additionally, participating CRNAs reported that after the intervention their awareness for the potential of perioperative CA increased and that the CA quick reference guide was a good reminder of high risk cases and useful for guiding their practice to prevent CAs. The increased awareness and reminder of high risk cases in the form of a simple educational initiative

and CA quick reference guide could serve to increase provider vigilance and subsequently decrease the incidence of CA.

Each of the four CRNAs who reported prior involvement in the care of a patient who sustained a CA reported the CA occurred due to mechanical trauma from the patient rubbing their eyes upon emergence or from equipment such as stethoscopes, identification badges, pulse oximeter probes, surgical drapes, or robotic surgical equipment. No CRNAs reported that the CA resulted from chemical trauma from solutions used by the surgeon in the patient's facial area for surgical preparation of the operative field. Sources of mechanical trauma lie directly under the control of anesthesia providers, emphasizing the importance of vigilance in regard to these foreign body mechanical sources of CA on the part of anesthesia providers in order to prevent perioperative CAs. In fact, multiple CRNAs in this project commented that vigilance on their part to protect the patient from these mechanical sources of CA is an important intervention. Vigilance on the part of the CRNA is paramount in robotic surgical cases in which mechanical sources of CA such as surgical arms of the robot are in close proximity to the patient's face.

As seen in Figure 4, while most CRNAs were highly confident in their ability to take appropriate measures to prevent CAs pre- and post-intervention, some improvement was still demonstrated after the intervention. Despite CRNAs' high level of confidence in their ability to implement appropriate CA prevention measures, there was significant variability in methods used to protect the eyes from CA. As seen in Figure 2, CRNAs at the partnering institution were fairly consistent with their chosen prevention method during a standard induction of general anesthesia. However, when CRNAs identified the patient as high risk for CA, prevention measures reported were variable, a trend that is consistent in the literature (Vetter et al., 2012). Additionally, CRNAs showed variability in the frequency of intraoperative eye assessment to

ensure protective measures remained intact. This variability emphasizes the need for standardized prevention protocols when prevention practices beyond the routine use of clear tape or paper tape are determined to be necessary by the CRNA.

Because most CRNAs could potentially be involved in the care of a patient who sustains a CA at some point in their career, it is important for them to know how to diagnose and treat CAs. Pre-intervention, CRNAs reported they were slightly, somewhat, or fairly confident in their ability to diagnose and treat a CA. After the educational intervention and access to a treatment algorithm, perceived confidence in their ability to diagnose and treat CAs increased, with most CRNAs reporting they were highly confident in these abilities. This project demonstrated that when additional information is provided, CRNAs are confident they can successfully diagnose and treat CAs in the perioperative setting.

As shown in Figure 3, CRNAs were divided about whether or not they would utilize the CA quick reference guide in their future practice, and none reported that they made changes to their current practice based on the guide. However, most indicated that the CA quick reference guide in combination with the PowerPoint presentation increased their awareness for the potential of perioperative CAs. This demonstrates that, although some providers may choose not to consistently access a quick reference guide, a simple educational initiative can increase awareness, serve as a reminder of patients who are at high risk, and be useful for CA prevention practices.

It should be noted that three of five CRNAs reported the CA quick reference guide was not useful for their practice to prevent CAs. One CRNA commented that a perceived barrier to the use of the quick reference guide was its bulky size, even though all CRNAs were provided with electronic access to the guide.

Section V. Implications

Financial and Nonfinancial Analysis

The simple educational initiative and CA quick reference guide used in this project resulted in an increase in CRNA perceived confidence in their ability to identify patients at high risk, implement appropriate prevention measures, and assess, diagnose, and treat perioperative CAs. A copy of an educational PowerPoint presentation regarding perioperative CA prevention was provided to CRNAs along with an electronic and hard copy of the CA quick reference guide. The CRNAs' viewing of a recorded PowerPoint presentation and electronic copy of the CA quick reference guide can be implemented with no financial cost to the institution other than a small time commitment from the participating CRNAs. The review of the recorded PowerPoint presentation was a total of approximately 8.5 to 10 minutes. The anesthesia group at the partnering institution participates in monthly department meetings which typically occur on weekdays in which surgeries start an hour later than normal, providing time for discussion of multiple topics. CRNAs can either be physically present or tune in virtually via Zoom technology. Allocating 15 minutes during monthly departmental meetings would provide an effective time for a 10 minute review of the recorded PowerPoint presentation with 5 minutes for questions. The educational presentation regarding CAs during monthly departmental meetings could be re-visited quarterly with discussion of progress, concerns, and relevant changes regarding the intervention. Although the time factor of 15 minutes for all CRNAs to participate could be calculated based on hourly salary, as training would be accomplished during routinely scheduled meetings designed to include sharing of practice information, the adjustment in productive work time would be negligible.

CRNAs in our project seemed to prefer electronic access to the CA quick reference guide, as only one CRNA commented that the hard copy was bulky in size. However, a financial

analysis of the cost to provide hard copies of the CA quick reference guide is necessary as some CRNAs may prefer to reference a hard copy. The quick reference guide was printed on standard printer paper and subsequently laminated. One ream of Hammermill Great White 30 8.5 x 11 printer paper contains 500 sheets for $20.14 for a total of $0.04 per sheet of paper. There are 70 practicing CRNAs and 27 practicing Anesthesiologists at the partnering institution requiring approximately 100 copies of the CA quick reference guide for a total of $4.00 in paper. The anesthesia department at the partnering institution uses an HP Laserjet Enterprise M577 printer. A full package of color and black toner for the printer is $423.74 on Amazon. It is unlikely that printing 100 copies of the CA quick reference guide would use an entire cartridge of toner, but pricing is included for completeness. Amazon Basics clear lamination sheets are $16.46 for a package of 100 sheets. The estimated total cost to supply each CRNA and Anesthesiologist at the partnering institution with a laminated copy of the CA quick reference guide is $444.20. This price could be reduced further by placing laminated copies of the CA quick reference guide in each operating room rather than supplying one to each anesthesia provider. There are a total of 26 operating rooms, 4 labor and delivery suites, 3 interventional radiology suites, and 7 cardiac operating rooms requiring a total of 40 copies of the CA quick reference guide.

The cost to the institution and anesthesia group when a CA occurs can be significant. CAs account for 35% of all perioperative ocular injury claims, and awards for ocular injury are typically 4% higher than any other claim (Papp et al., 2019). In their closed claims analysis, Gild et al. (1992) reported that financial awards to patients who sustain a CA range from $25 to $25,000 with a median payment of $3,000. Further, in institutions that use ophthalmology consults rather than anesthesiology led treatment of CAs, an extended time to treatment of CAs can create significant PACU delays. As previously mentioned in the literature review, Segal et

al. (2014) identified that it can take approximately 5 hours after onset of symptoms of a CA for a patient to receive an ophthalmology consult. Lichter et al. (2015) was able to utilize an anesthesiology led treatment protocol in order to reduce the time to treatment of CA to 3 hours. A time savings of 2 hours can be accomplished by using an anesthesiology led CA treatment protocol rather than ophthalmology consult. This time savings translates into continued patient movement from the operating room, to the PACU, and then to discharge or placement in an inpatient room. This facilitated movement through the PACU prevents significant operating room delays that can be costly. In one report it was estimated that a loss of 631 hours of operative time due to late starts cost their institution $390,589 (Hicks et al., 2020). This translates to a cost of $619 for each hour of operating room delay. In addition to the decreased financial cost, the prompt treatment of CAs in the PACU by the anesthesia team as opposed to ophthalmology consult can decrease patient suffering by shortening the time to treatment and resolution of painful symptoms.

Potential cost savings to the institution and anesthesia group by implementing a simple CA educational initiative, with provision of a CA quick reference guide including a prevention and treatment algorithm, are significant. By implementing an anesthesiology led treatment protocol, time savings as a result of continued movement through the PACU can potentially be translated into less operating room delays resulting in significant financial savings to both the institution and anesthesia group. Vetter et al. (2012) implemented a similar intervention which included educational presentations to staff, online access to an eye protection protocol, and a documentation short cut. They demonstrated a decrease in the incidence of CA at their institution with an estimated cost savings of $637 per CA prevented.

Implications of Project

The AANA Standards for Nurse Anesthesia Practice require CRNAs to monitor the patient's position during surgery to prevent injury and to monitor and document the patient's physiologic condition (n.d.). However, they have not endorsed a standard of care regarding prevention of perioperative CAs. The partnering institution also does not endorse a particular standard of care for prevention of perioperative CAs. Additionally, the partnering institution lacks streamlined documentation of eye protection strategies requiring CRNAs to input narrative notes into the anesthesia record. This practice is time consuming and could lead to absent or inadequate documentation of eye protection.

The first step to preventing a CA is identifying patients at high risk (Kaye et al., 2019). Patients can be identified as high risk for CA based upon co-morbid conditions, surgical factors, and surgical positioning. CRNAs participating in this project were consistent with the literature in their identification of high risk patient populations and reported they were fairly to highly confident pre-intervention in their ability to identify these patients. The lack of a specific recommendation to protect patients from CAs allows CRNAs to select prevention modalities and may lead to variable practices amongst CRNAs. This variation in anesthesia practice to prevent CAs is not uncommon and was reported in the literature by Vetter et al. (2012). CRNAs at the partnering institution of this QI project reported being fairly to highly confident in their ability to implement appropriate measures to prevent CA. However, they demonstrated variable practices to prevent CAs when the patient is identified to be at high risk. After this intervention, CRNAs reported that they were more confident in their ability to identify patients at high risk and to take appropriate measures to prevent perioperative CAs. By providing CRNAs with guidance regarding CA prevention methods, and taking steps towards a recommended standard of care, it

is possible to promote more consistent use of prevention measures amongst CRNAs, potentially leading to a decreased incidence of CA.

Although some CRNAs were unlikely to use the CA quick reference guide in the future and no CRNAs changed their current practice, they reported that the CA quick reference guide was helpful with identification of high risk cases and was a useful guide for selection of appropriate prevention measures. A perceived barrier to the use of the reference guide identified by one CRNA was its bulky size. Recommendations for future improvements to the project should include a smaller step-by-step algorithm to guide CRNAs on the appropriate use of prevention measures for specific patient and surgical scenarios. For example, current literature recommends the use of Tegaderm in high risk cases such as surgery in the head or neck area; lateral, prone, or Trendelenburg positions; and surgeries anticipated to be long in duration (Grixti et al., 2013; Kaye et al., 2019; Malafa et al., 2016; Papp et al., 2019). The improved CA quick reference guide could include an algorithm that recommends the CRNA to use Tegaderm in these specific cases.

Overall, CRNAs were less confident in their ability to assess, diagnose, and treat CA than they were with identifying patients at high risk and implementing appropriate prevention methods. After implementation of this educational PowerPoint and provision of a stepwise treatment algorithm, CRNAs participating in this project reported the highest increase in their perceived confidence in their ability to assess, diagnose, and treat a CA. Continued work in this area could allow for anesthesia led treatment of CAs in the PACU facilitating PACU and operating room turnover translating into time and cost savings.

This QI project addressed the Institute for Healthcare Improvement's Triple Aim (n.d.) in order to improve patient care quality and satisfaction, improve the health of populations, and

reduce the cost of healthcare. By providing CRNAs with guidance regarding the appropriate prevention measure to utilize with specific surgeries and patient populations, there is potential to reduce the incidence of perioperative CAs, improve patient care quality, and reduce the cost associated with CA. Based on findings from this project, developing a small and compact algorithm for selection of an appropriate treatment algorithm would be useful. Further, by providing the anesthesia department with a treatment algorithm, we hoped to give the anesthesia department guidance regarding the treatment of CA so as to make progress towards anesthesiology led treatment of perioperative CAs. By allowing anesthesia staff to treat CAs, as opposed to ophthalmology consult, PACU throughput could be facilitated, leading to reduced operating room delays that could translate into significant financial savings.

Sustainability

The simplicity of this QI project lends itself to long-term sustainability at the partnering institution. The project would be financially inexpensive to the institution costing as much as $444.20 if hard copies of the CA quick reference guide were printed, laminated, and supplied to each anesthesia provider. This cost could be reduced by only placing the reference guide in operating rooms and further by only providing electronic access to the guide. Presentation of the PowerPoint recording during a monthly departmental meeting would require about 15 minutes time. Allowing time at quarterly departmental meetings for discussion of progress, questions, and relevant updates on the initiative could serve as continued reinforcement of the project. This time could also serve as a time for root-cause-analysis of cases of CAs that have occurred and allow for improvements to the prevention algorithm. With a similar intervention utilizing departmental education and eye protection protocols with continued reinforcement, Vetter et al. (2012) reported a sustained decrease in the incidence of CA for 45 months.

Development of a more streamlined CA quick reference guide to assist anesthesia providers in the selection of the most appropriate CA prevention measure in specific situations may be useful. Improving the CA quick reference guide to consist of a simple algorithm for providers to follow when selecting a CA prevention measure could be a vital step to the development of standardized practice at the partnering institution. Successful implementation of a CA prevention measure algorithm at the partnering institution could lead to the adoption of standardized CA prevention throughout the local anesthesia community.

Implementation of the anesthesiology-led treatment of CAs in the PACU using this treatment algorithm could translate into significant reductions in time to treatment of a CA. By avoiding the need to wait for an ophthalmology consultation, patients could be treated immediately in the PACU and subsequently discharged or moved to an inpatient bed. Continued movement through the PACU could serve to reduce operating room delays resulting in significant cost savings. By reducing the incidence of perioperative CAs the anesthesia group could save a median of $3,000 per CA in legal awards to patients who sustain a perioperative CA (Gild et al., 1992).

AANA Standard 5 of The Standards of Nurse Anesthesia Practice requires CRNAs to provide accurate and complete documentation in the patient's healthcare record. Similar to findings of Carniciu et al. (2017), the partnering institution lacked documentation standards for eye protection utilized during anesthesia. Current eye care electronic documentation at the partnering institution only allows for documentation that eyes were secured with tape during induction as part of the airway procedure note. Further electronic documentation would require a narrative note from the provider describing eye protection methods utilized. All CRNAs

participating in this project indicated that more streamlined documentation of eye protection strategies used would be beneficial for their practice.

Vetter et al. (2012) demonstrated a 3.4% to 74.9% improvement in eye protection documentation compliance after implementation of a documentation shortcut. In this project the partnering institution uses Epic as their electronic health record platform. After implementation and data collection, the project team lead discussed project findings with the Epic champion at the institution. The Epic champion is a CRNA who serves as a mediator between anesthesia providers at the institution and the Epic information technology team. The project team lead provided results of this project to the Epic champion and made recommendations of changes to be made to the Epic platform for eye care documentation. The Epic champion submitted an email to Epic platform designers of the proposed changes. Because there are seven institutions affiliated with the partnering institution that utilize the same platform, approval had to be obtained from a governing committee. Approval and rollout of the documentation updates took ten business days before it was available as part of the electronic health record.

Changes to electronic documentation allow for more streamlined documentation of eye protection used by CRNAs. One-click buttons were added to the positioning note which allows CRNAs to choose between clear tape, paper tape, Tegaderm, eye lubricant, or goggles. The original platform also allowed for multiple selections if more than one prevention measure was utilized. The new documentation system allows for selection of a template that automatically files specific selections that are commonly used. For example, if the anesthesia provider selects the button “Supine”, the positioning note will automatically generate the most common selections made for a patient in the supine position. The eye care documentation section of the positioning note automatically populates to the clear tape selection. Despite the change to the

electronic documentation system, all anesthesia providers at the partnering institution were not made aware of the change. Because all CRNAs were not notified of the change, some patient records reflected that patients undergoing monitored anesthesia care, in which patients were awake and able to spontaneously open their eyes, erroneously recorded that their eyes were taped closed with clear tape. Future recommendations for sustainability of the project include changing the eye care documentation so that it does not automatically populate a selection and requires the anesthesia provider to make their own selection for eye care documentation.

Sustainability of this project could be limited by CRNAs' willingness to utilize the CA quick reference guide. Currently, the CA quick reference guide contains ample information regarding prevention of CA. It was reported in this project that the reference guide was bulky in size. The abundance of information on our guide could make it difficult for CRNAs to access the information they need to make a decision regarding the use of a specific prevention measure time consuming. In an environment that creates significant production pressure, this could dissuade CRNAs from using the guide. To support sustainability, improving the prevention method guide to resemble the treatment algorithm by guiding the CRNA on which prevention measure is best for a specific patient and surgical scenario could make the guide more conducive for use, increasing the potential for long term sustainability of the change.

Dissemination Plan

Dissemination of the results of this QI project included a poster presentation which was presented to East Carolina University College of Nursing Nurse Anesthesia program students and faculty. Additionally, project participants, CRNAs at the partnering institution, and East Carolina University College of Nursing staff were invited to attend. The final version of this paper was also uploaded in The Scholarship, the East Carolina University digital repository.

Section VI. Conclusion

Limitations

The population of this QI project was intended to be CRNAs providing anesthesia for spinal surgery cases. However, the project team lead identified that CRNAs participating in the project were not preferentially assigned to spinal surgery cases. While the implications of this QI project are still the same, it should be noted that the project population was not limited to CRNAs providing anesthesia during spinal surgery. This could have potentially been due to anesthesia staffing limitations during the time period of the project. Additionally, the QI project utilized a small convenience sample of 5 participating CRNAs at a single institution. This limits the generalizability of the findings of the project to a larger population.

This QI project was developed by the project team prior to the SRNA team members starting their clinical education. While the project chair was able to act as a clinical expert on the topic of CAs and guide SRNA team members in designing the intervention, SRNA team members may have designed the intervention differently after having clinical experience. For example, the CA quick reference guide did contain an overwhelming amount of information and may have been too exhaustive for actual clinical use. The CA quick reference guide was developed from the perspective of educating CRNAs about CA prevention. After having clinical experience, the SRNA team lead recognizes that most CRNAs know how to identify patients at high risk for CA and methods used to prevent them. However, there may be more confusion about which patient and surgical situations warrant which prevention methods. Knowing this prior to project development, it is likely that the SRNA team members would have designed an actual algorithm based on current literature review for CRNAs to follow when making decisions about eye protection for specific patients, surgical cases, and positioning requirements. CRNAs

participating in the study may have found an eye protection algorithm to be more useful in clinical practice.

The design of some of the survey questions may also have been a limitation to the project. For example, question three and four on the pre-intervention survey, which allowed for multiple responses, did not differentiate whether or not CRNAs were using these prevention measures individually or in combination. CRNAs who selected that they used clear tape, eye lubricant, and goggles could have been indicating they used all three methods in combination. But they could have also intended to indicate that they used clear tape for one patient, eye lubricant for another, and goggles for yet another patient that they identified as high risk for different reasons.

Recommendations for Future Implementation and/or Additional Study

If this project were to be duplicated or continued, the primary investigator recommends reconstructing the CA quick reference guide to include only an algorithm guiding CRNAs on which CA prevention measure to choose for specific patient and surgical scenarios based on the current literature recommendations. Providing CRNAs with faster and more streamlined decision making ability in a fast paced surgical environment is necessary. This QI project provided CRNAs with access to a CA treatment algorithm but did not pilot its use in an actual PACU setting. CRNAs reported their confidence in their ability to treat CAs improved after having access to the treatment algorithm. As a result of the increased confidence in CRNA ability to treat CAs, the project team lead recommends future studies to pilot the use of the treatment algorithm and assess its effectiveness.

In continuation of this project, emphasis should be placed on the treatment algorithm and implementation of anesthesiology-led CA treatment into standard practice. Variability was seen

in prevention practices utilized when CRNAs identified their patient to be at high risk for CA, indicating a potential need for standardized practice. CRNA reluctance to use the CA quick reference guide in this project suggests they may prefer a smaller, more streamlined decision making algorithm. The CA quick reference guide was detailed and contained a lot of information that may have been overwhelming to an anesthesia provider looking for a quick guide to their practice in a fast paced environment. While information regarding the pathophysiology of CA may be interesting, it is likely more information than a CRNA needs when trying to make a quick decision about what prevention measure they will utilize in a specific case. It may be beneficial to create a prevention algorithm such as a simple flowchart that guides CRNAs on the best prevention measure to utilize with a specific patient or surgical case. In a fast paced surgical environment with production pressure, CRNAs need to be able to make a quick decision regarding implementation of the proper prevention measure. We suggest placing this prevention algorithm in the operating room where CRNAs can have quick access, such as on the wall near an anesthesia workstation.

The use of a standardized prevention algorithm could be trialed to assess whether CRNAs with access to such an algorithm feel more confident in their ability to protect patients from CAs than a control group without access to a standardized prevention algorithm. Additionally, the study could follow patients in the intervention and control group and compare rates of sustained CAs in each group. Identification that CRNAs are more comfortable in their practice to prevent CAs when provided with prevention algorithms and improved incidence of CAs as a result, could lead to standardized practice to prevent CAs.

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Appendix A

Literature Concept Table and Search Strategy

	Concept 1: Corneal Abrasions	Concept 2: Operating Room	Concept 3: CRNAs
Keywords (these are the "normal" words you would use anywhere)	Corneal injury Corneal abrasion	Surgery Surgical procedures Surgical procedures, operative Perioperative Operating room	Nurse anesthetists Nurse anaesthetists Anesthesia Anaesthesia Anesthesiology Anesthesiologist
PubMed MeSH (subject heading specific to PubMed)	"cornea"[MeSH Terms] "corneal injuries"[MeSH Terms] "eye injuries"[MeSH Terms]	"surgery"[MeSH Subheading] "surgical procedures, operative"[MeSH Terms] "general surgery"[MeSH Terms] "surgical procedures, operative"[MeSH Terms] "operating rooms"[MeSH Term]	"nurse anesthetists"[MeSH Terms] "anesthetists"[MeSH Terms] "anesthesia"[MeSH Terms] anesthesiology"[MeSH Terms] "anesthesiologists"[MeSH Terms]
CINAHL Subject Terms (Subject headings specific to CINAHL)	(MH "Corneal Injuries") (MH "Eye Injuries")	(MH "Operating Rooms") (MH "Surgery, Operative") (MH "Intraoperative Period") (MH "Intraoperative Care") (MH "Intraoperative Complications") (MH "Intraoperative Monitoring")	(MH "Nurse Anesthetists") (MH "Anesthesia") (MH "Anesthesia Recovery") (MH "Anesthesiology") (MH "Anesthesiologists")
Other (Google Scholar)			

PubMed:
(Surgery OR surgical procedures OR perioperative OR operating rooms) AND (corneal injuries OR corneal abrasions OR eye injury OR ocular injury) AND (nurse anesthetists OR nurse anaesthetists OR anesthesia OR anaesthesia OR anesthesiology OR anesthesiologist)

PubMed translation of search query:
("surgery"[MeSH Subheading] OR "surgery"[All Fields] OR "surgical procedures, operative"[MeSH Terms] OR ("surgical"[All Fields] AND "procedures"[All Fields] AND "operative"[All Fields]) OR "operative surgical procedures"[All Fields] OR "general surgery"[MeSH Terms] OR ("general"[All Fields] AND "surgery"[All Fields]) OR "general surgery"[All Fields] OR "surgery s"[All Fields] OR "surgerys"[All Fields] OR "surgeries"[All Fields] OR ("surgical procedures, operative"[MeSH Terms] OR ("surgical"[All Fields] AND "procedures"[All Fields] AND "operative"[All Fields]) OR "operative surgical procedures"[All Fields] OR ("surgical"[All Fields] AND "procedures"[All Fields]) OR "surgical procedures"[All Fields]) OR ("perioperative"[All Fields] OR "perioperatively"[All Fields]) OR ("operating rooms"[MeSH Terms] OR ("operating"[All Fields] AND "rooms"[All Fields]) OR "operating rooms"[All Fields])) AND ("corneal injuries"[MeSH Terms] OR ("corneal"[All Fields] AND "injuries"[All Fields]) OR "corneal injuries"[All Fields] OR ("corneal injuries"[MeSH Terms] OR ("corneal"[All Fields] AND "injuries"[All Fields]) OR "corneal injuries"[All Fields] OR ("corneal"[All Fields] AND "abrasions"[All Fields]) OR "corneal abrasions"[All Fields]) OR ("eye injuries"[MeSH Terms] OR ("eye"[All Fields] AND "injuries"[All Fields]) OR "eye injuries"[All Fields] OR ("eye"[All Fields] AND "injury"[All Fields]) OR "eye injury"[All Fields]) OR ("eye injuries"[MeSH Terms] OR ("eye"[All Fields] AND "injuries"[All Fields]) OR "eye injuries"[All Fields] OR ("ocular"[All Fields] AND "injury"[All Fields]) OR "ocular injury"[All Fields])) AND ("nurse anesthetists"[MeSH Terms] OR ("nurse"[All Fields] AND "anesthetists"[All Fields]) OR "nurse anesthetists"[All Fields] OR (("nurse s"[All Fields] OR "nurses"[MeSH Terms] OR "nurses"[All Fields] OR "nurse"[All Fields] OR "nurses s"[All Fields]) AND ("anaesthetist s"[All Fields] OR "anesthetist s"[All Fields] OR "anesthetists"[MeSH Terms] OR "anesthetists"[All Fields] OR "anaesthetist"[All Fields] OR "anaesthetists"[All Fields] OR "anesthetist"[All Fields])) OR ("anaesthesia"[All Fields] OR "anesthesia"[MeSH Terms] OR "anesthesia"[All Fields] OR "anaesthesias"[All Fields] OR "anesthesias"[All Fields]) OR ("anaesthesia"[All Fields] OR "anesthesia"[MeSH Terms] OR "anesthesia"[All Fields] OR "anaesthesias"[All Fields] OR "anesthesias"[All Fields]) OR ("anaesthesiology"[All Fields] OR "anesthesiology"[MeSH Terms] OR "anesthesiology"[All Fields] OR "anesthesiology s"[All Fields]) OR ("anaesthesiologist s"[All Fields] OR "anesthesiologist s"[All Fields] OR "anesthesiologists"[MeSH Terms] OR "anesthesiologists"[All Fields] OR "anaesthesiologist"[All Fields] OR "anaesthesiologists"[All Fields] OR "anesthesiologist"[All Fields]))

CINAHL:
((MH "Corneal Injuries") OR "Corneal injuries" OR (MH "Eye Injuries") OR "Eye injury" OR "Ocular injury" OR "Corneal abrasion") AND ((MH "Operating Rooms") OR "Operating rooms" OR "Surgery" OR (MH "Surgery, Operative") OR "Surgery, operative" OR "Surgical procedures" OR (MH "Intraoperative Period") OR "Intraoperative period" OR (MH "Intraoperative Care") OR "Intraoperative care" OR (MH "Intraoperative Complications") OR "Intraoperative complications" OR (MH "Intraoperative Monitoring") OR "Intraoperative monitoring" OR "Perioperative") AND ((MH "Nurse Anesthetists") OR (MH "Anesthesia") OR "Anesthesia" OR (MH "Anesthesia Recovery") OR "Anesthesia recovery" OR (MH "Anesthesiology") OR "Anesthesiology" OR (MH "Anesthesiologists") OR "Anesthesiologists")

Google Scholar:
(Surgery OR surgical procedures OR perioperative OR operating rooms) AND (corneal injuries OR corneal abrasions OR eye injury OR ocular injury) AND (nurse anesthetists OR nurse anaesthetists OR anesthesia OR anaesthesia OR anesthesiology OR anesthesiologist)

Appendix B

Literature Search Log

Search date	Database or search engine	Search strategy	Limits applied	Number of citations found/kept	Rationale for inclusion/exclusion of items
9/21/2021	PubMed	(Surgery OR surgical procedures OR perioperative OR operating rooms) AND (corneal injuries OR corneal abrasions OR eye injury OR ocular injury) AND (nurse anesthetists OR nurse anaesthetists OR anesthesia OR anaesthesia OR anesthesiology OR anesthesiologist)	English/2009 – September 2021 (much of research is outdated)	342 found/23 kept	Inclusion: Perioperative corneal abrasions or ocular injuries causes, incidence, risk factors, guidelines, treatment and performance improvement programs, use of eye care protocols/QI projects Exclusion: not related to corneal abrasions or ocular injury, ocular surgery
9/21/2021	CINAHL	((MH "Corneal Injuries") OR "Corneal injuries" OR (MH "Eye Injuries") OR "Eye injury" OR "Ocular injury" OR "Corneal abrasion") AND ((MH "Operating Rooms") OR "Operating rooms" OR "Surgery" OR (MH "Surgery, Operative") OR "Surgery, operative" OR "Surgical procedures" OR (MH "Intraoperative Period") OR "Intraoperative period" OR (MH "Intraoperative Care") OR "Intraoperative care" OR (MH "Intraoperative Complications") OR "Intraoperative	English language/Peer reviewed/2009 – September 2021 (much of research is outdated)	122 found/5 kept	Inclusion: Guidelines for prevention of corneal abrasions, eye care education programs, use of eye care protocols, education intervention, visual aid Exclusion: not related to corneal abrasions or duplicated in PubMed search, ocular surgery

		complications" OR (MH "Intraoperative Monitoring") OR "Intraoperative monitoring" OR "Perioperative") AND ((MH "Nurse Anesthetists") OR (MH "Anesthesia") OR "Anesthesia" OR (MH "Anesthesia Recovery") OR "Anesthesia recovery" OR (MH "Anesthesiology") OR "Anesthesiology" OR (MH "Anesthesiologists") OR "Anesthesiologists")			
9/21/2021	Google Scholar	(Surgery OR surgical procedures OR perioperative OR operating rooms) AND (corneal injuries OR corneal abrasions OR eye injury OR ocular injury) AND (nurse anesthetists OR nurse anaesthetists OR anesthesia OR anaesthesia OR anesthesiology OR anesthesiologist)	2009 – September 2021 (much of research is outdated)	2050 found/6 kept (15 pages reviewed)	Inclusion: Use of eye care protocols, education intervention, visual aid Exclusion: not related to Perioperative corneal abrasions or duplicated in PubMed/CINAHL search, ocular surgery

Appendix C

Literature Matrix

Author, Title, Journal	Purpose & Conceptual Framework or Model	Design and Level of Evidence	Setting	Sample	Tool/s and/or Intervention/s	Results
Carniciu, A., Fazzari, M., Tabibian, P., Batta, P., Gentile, R., Grendell, J., Brathwaite, C., & Barzideh, N. (2017). Corneal abrasion following anaesthesia for non-ocular surgical procedures: A case-controlled study. *Journal of Perioperative Practice, 27*(11), 247-253. https://doi.org/10.1177/1750458917021102	Purpose: to determine CA risk factors and investigate ocular disease and diabetes as novel risk factors No framework or model noted	Retrospective Case-Control Level V	Single Institution in Postoperative Care Unit	37 Cases of CA compared to 101 controls	N/A	Risk factors: longer duration of surgery (4.6x greater risk with surgery > 3 hours), pre-existing ocular disease (3.6x greater risk), 16.7x greater risk with long surgery + ocular disease), procedures involving the head/neck. Medical records did not document whether eyes were protected during surgery and method not known making analysis of prevention practices impossible. No standardized protocol at institution for eye protection and anesthesia community recommends no standard of care. Recommend institutions develop CA prevention protocols, educational initiates, and required documentation of prevention strategy.
Ely, A. L., Goerlitz-Jesssen, M., Scott, I. U., Lehman, E., Ali, T., Kerchner, D., & Liang, D. (2019). An ophthalmology resident-led quality improvement initiative to decrease the incidence of perioperative corneal injury. *Journal of Academic Ophthalmology, 11*(2), e49-e53. http://dx.doi.org/10.13039/100000002	Purpose: evaluate the effectiveness of ophthalmology resident-led QI initiative for corneal injury prevention No framework or model noted	Quality Improvement Level VI	Single large academic institution	55 cases of CA compared to 20,187 controls	Educational lecture and material distribution focused on CA awareness, risk factors, and algorithm to prevent CAs	Educational intervention and prevention algorithm directed towards anesthesia staff resulted in decrease in CA incidence from 0.37% pre-initiative to 0.19% post-initiative. Risk factors identified: lateral/prone positioning, longer surgical duration, vascular surgery service.

Grixti, A., Sadri, M., & Watts, M. T. (2013). Corneal protection during general anesthesia for nonocular surgery. *The Ocular Surface, 11*(2), 109 – 118. https://dx.doi.org/10.1016/j.jtos.2012.10.003	Purpose: identify etiology of perioperative CAs and compare protection strategies used No framework or model noted	Systematic Review Level I	N/A	52 articles identified based on etiology and prevention of CAs. Total of 9 articles met inclusion criteria, 8 RCTs and 1 historical controlled study	Databases reviewed: CINAHL, MEDLINE, Embase	RCTs all from 1977 – 1998 (evidence is out-dated). Risk factors identified are long surgical procedures, lower ASA physical status, anesthesia provided by SRNA, intraoperative hypotension and anemia, damage from anesthesia equipment (badges, stethoscopes, laryngoscopes, etc.), prone/Trendelenburg positioning, operations to head/neck area, diabetics, oxygen facemask/pulse oximetry probe in PACU. Simple horizontal rather than vertical taping of the eyelids was identified as effective, as well as the use of bio-occlusive dressings and ocular lubricants. Educational interventions were identified to have significant effect on provider awareness and decreased incidence of CA. Recommend simple eyelid taping and use of bio-occlusive dressings/ointments in high risk cases (head/neck surgery, prolonged, prone/lateral position). Use of 4% methylcellulose is best as it does not absorb more soluble anesthetics like paraffin based ointments. They recommend further research (RCTs) on more modern prevention strategies.
Kaye, A. D., Renschler, J. S., Cramer, K. D., Anyama, B. O., Anyama, E. C., Gayle, J. A., Armstead-Williams, C., Mosieri, C. N., Saus, J. A., & Cornett, E. M. (2019). Postoperative management of corneal abrasions and clinical implications: A comprehensive review. *Current Pain & Headache Reports, 23*(7). https://doi.org/10.1007/s11916-019-0784-y	Purpose: review of the literature to discuss risk factors, incidence, prevention, diagnosis, and treatment of CAs No framework or model noted	Review, Expert Opinion Level VII	N/A	N/A	None	Anesthesia Risk factors: lagophthalmos and corneal drying, loss of Bell's Phenomenon, decreased tear production, loss of corneal blink reflex Sources of CA: Bair hugger, oxygen masks, identification badges, watch straps, surgical drapes, pulse ox on dominant hand Surgical/demographic risk factors: lateral/prone/Trendelenburg position, head/neck surgery, spillage of antiseptic solution into eye, long surgery, advanced age, exophthalmos, dry eyes Diagnosis: eye pain, blurry vision, photophobia, foreign body sensation, definitive with fluorescein staining

						Prevention: tape is best, tape immediately following induction petroleum gel is flammable and avoid with high FiO2 and electrocautery, Tegaderm/Bio-occlusive is more water-tight Treatment: erythromycin 0.5% 4x/day for 48 h, potential for pseudomonal infections in those wearing contacts (use Gram negative), 0.05% proparacaine/1% tetracaine for pain, oral NSAIDs for pain, topical NSAIDs for pain, cycloplegics (cyclopentolate 0.5-1% 2x/day or homatropine 2.5-5% 1x/day) for large CAs.
Lichter, J. R., Marr, L. B., Schilling, D. E., Hudson, M. E., Boretsky, R. H., Barad, R. F., & Chelly, J. E. (2015). A department-of-anesthesiology-based management protocol for perioperative corneal abrasions. *Clinical Ophthalmology*, *2015*(9), 1689-1695. https://doi.org/10.2147/OPTH.S84367	Purpose: develop a treatment algorithm for CAs and evaluate efficacy. Also established risk factors and incidence of CA. No framework or model noted	Observational Level IV	PACU	91,064 surgical cases with 118 CAs identified and treated	Anesthesiology based management protocol for treatment of CAs after initial compliant of eye pain in the PACU	Anesthesiology led protocol for treatment of CAs was successful in treating 93% of patients with CAs with REFRESH artificial tears alone or in combination with 0.5% erythromycin ointment. Mean time to treatment was 177.84 min. and all experienced resolution of symptoms within 24 hours of treatment. Risk factors: Advanced age (mean 64.49 compared to 58.1 years in non-injury patients). Long surgical duration (mean of 207.93 min. compared to 132.73 in non-injury patients.)
Malafa, M. M., Coleman, J. E., Bowman, R. W., & Rohrich, R. J. (2016). Perioperative corneal abrasion: Updated guidelines for prevention and management. *Plastic and Reconstructive Surgery*, *137*(5), 790e-798e. https://doi.org/10.1097/PRS.0000000000002108	Purpose: literature review to establish pathology, incidence, risk factors, prevention, diagnosis, and treatment of CAs	Review, Expert Opinion Level VII	N/A	N/A	None	Anesthesia Risk Factors: GA suppresses protective mechanisms (corneal reflex, Bell phenomenon, reflecting tearing), increases lagophthalmos and diminishes tear production producing corneal drying Risk factors: advanced age, exophthalmos, dry eye, long surgery (60-90 min.), prone/lateral/Trendelenburg position, head/neck surgery, intraoperative hypotension, preoperative anemia

	No framework or model noted					Sources of CA: laryngoscope, O2 face mask, name badge, watch band, surgical prep, surgical drapes, patient fingers/pulse ox Diagnosis: abrupt pain within 2 hours of procedure, foreign body sensation, blurry vision, excessive tearing, photophobia. Evert eyelids to r/o foreign body, assess visual acuity, extraocular movements, pupils, fluorescein staining. Pain should improve within 48 hours – ocular emergency refer to ophthalmologist Prevention: secure eyelids after induction with tape or Tegaderm if high risk. Lubricants if not taping: preservative free, methylcellulose solution is best but no advantage over taping alone Treatment: Oral NSAIDs, 1% tetracaine or 0.1-0.5% proparacaine for pain limited to first 24 hours to prevent masking worsening condition, topical NSAIDs limited to 1-2 days due to corneal toxicity, eye patching not recommended. Topical antibiotic (erythromycin, bacitracin, polymyxin, sulfacetamide) and anti-pseudomonal coverage if contacts used (ofloxacin/moxifloxacin). Preservative free lubricants (Systane or Refresh). Steroids contraindicated due to infection risk and patching contraindicated. Refer to ophthalmology: worsening pain/vision after 24h or any pain persisting 48hr, failure to completely heal by 72h.
Martin, D. P., Weingarten, T. N., Gunn, P. W., Lee, K., Mahr, M. A., Schroeder, D. R., & Sprung, J. (2009). Performance improvement system and postoperative corneal injuries: Incidence and	Purpose: evaluate the effectiveness of a performance improvement initiative to reduce the rate	Observational Performance Improvement Case-Control (identified risk factors)	Large Academic Medical Center	113,162 non-ocular surgeries with 128 identified eye injuries	Web-based reporting tool of ophthalmologist diagnosed CAs and email notification of anesthesia	Incidence of CAs decreased from 1.51/1000 pre-PI, 1.37 after email notification (awareness), 0.79 after education, to 0.47 in 15 month follow-up period (demonstrated continued improvement). Simple awareness and on-going education of CAs without a change in policy still produced improvement.

risk factors. *Anesthesiology*, *111*(2), 320-326. http://dx.doi.org/10.1097/ALN.0b013e3181ae63f0	of perioperative CAs. Also examined risk factors of CAs No framework or model noted	Level VI		Case/Control: 117 cases compared to 234 controls	provider followed by 45 min educational lecture from ophthalmologist to anesthesia providers regarding corneal injury awareness, risk factors, prevention	Risk factors: SRNA as provider highest risk, longer surgery duration (271 +/- 116 min. vs. 206 +/- 118 min. for controls), head and neck surgery (15.4% cases vs. 9% controls), Graves' disease
Papp, A. M., Justin, G. A., Vernau, C. T., Aden, J. K., Fitzgerald, B. M., Kraus, G. P., & Legault, G. L. (2019). Perioperative corneal abrasions after nonocular surgery: A systematic review. *Cornea*, *38*(7), 927–932. https://dx.doi.org/10.1097/ICO.0000000000001972	Purpose: systematic review of the literature to determine risk factors and compare effectiveness of prevention strategies and treatment for CAs No framework or model noted	Systematic Review Level I	N/A	204 Articles identified, 16 met inclusion criteria	Databases reviewed: PubMed, Embase, and EBM reviews PRISMA diagram for selection of included articles	No standard of care identified. Tegaderm/Bio-occlusive dressing most used strategy. Standardized ocular protection, reporting, and education should be implemented to decrease rates of CAs. Rate of CAs found to be 0.64% overall. They suggest a web based reporting tool and checklist with multi-phased lecture series taught by ophthalmologist and anesthesiologist, and encourage involvement of ophthalmologist. Recommend use of bio-occlusive dressing with ointment.
Sampat, A., Parakati, I., Kunnavakkam, R., Glick, D. B., Lee, N. K., Tenney, M., Eggener, S., & Roth, S. (2015). Corneal abrasion in hysterectomy and prostatectomy. *Anesthesiology*, *122*(5), 994-1001. https://dx.doi.org/10.1097/ALN.0000000000000630	Purpose: determine incidence of CA after prostatectomy and hysterectomy and to examine risk factors No framework or model noted	Retrospective Uncontrolled Case-Control Level V	Nationwide Inpatient Sample (NIS) database used to randomly select over 1,000 hospitals in 44 states and identified discharges with radical prostatectomy, open hysterectomy, laparoscopic hysterectomy	Years 2000-2011 166,942 RP: 295 CAs 216,890 L/HYST: 275 CAs 583,298 O/HYST: 189 CAs	NIS database	RP and hysterectomy require steep Trendelenburg position increasing IOP and venous pressure leading to corneal edema and inability to close eyelids sufficiently. From 2009 – 2011 showed four times higher risk with L/HYST and seven times higher risk when robotically assisted compared with open. Laparoscopy and robotic assistance contribute independently to CA risk. Recommend vigilance and methods developed to lower incidence of CA. RP incidence: 0.18 L/HYST incidence: 0.13

						O/HYST incidence: 0.03
Segal, K. L., Fleischut, P. M., Kim, C., Levine, B., Faggiani, S. L., Banerjee, S., Gadalla, F., & Lelli, G. J. (2014). Evaluation and treatment of perioperative corneal abrasions. *Journal of Opthalmology*, *2014*(4). https://dx.doi.org/10.1155/2014/901901	Purpose: identify risk factors, evaluate time to treatment, and develop protocol for treatment No framework or model noted	Retrospective Case-Control Level V	Collaboration between anesthesiology/ophthalmology at large Academic Medical Center	86 CA cases 89 Controls	Developed a CA treatment algorithm	Risk Factors: age (55), urological surgery, robotic prostatectomy, longer operative time (3.85 hours), general anesthesia, prone/Trendelenburg positioning, supplemental oxygen use during transport, glasses/contact wearers, history of dry eye or ocular disease (glaucoma, cataracts), large estimated blood loss Facility currently used ophthalmology consult which increases time to treatment as opposed to anesthesiology Management. Time to complaint was 129 min. + 164 min. to consult. Proposed/developed a simple treatment algorithm for anesthesia management of CA and education to identify and treat CAs to decrease time to treatment. Recommend anesthesia to initiate treatment prior to consulting ophthalmology. Patient an be discharged from PACU with treatment and follow-up with ophthalmology as needed. Treatment recommended: erythromycin 4x/day for 48 hours
Vetter, T. R., Ali, N. M., & Boudreaux, A. M. (2012). A case-control study of an intraoperative corneal abrasion prevention program: Holding the gains made with a continuous quality improvement effort. *Joint Commission Journal on Quality and Patient Safety*, *38*(11), 490-496. https://doi.org/10.1016/s1553-7250(12)38065-3	Purpose: Quality Improvement project utilizing educational interventions and online eye-protection protocol to improve incidence of CAs No framework or model noted	QI – cohort study Level VI	Large Academic Medical Center	50,151 pre-intervention (48 CAs reported) 113, 044 post-intervention (10 CAs reported)	Standardized eye protection protocol/documentation implemented.	The QI project observed provider practices regarding eye care and noted high variability in appreciation of importance and inconsistent use of eye protection strategies. Implemented departmental standard of care, documentation short cut to increase documentation, educational presentations, and online eye-protection protocol made available. Decreased incidence from 1.2/1000 surgeries to 0.09/1000 post-intervention and increased documentation from 3.4% to 74.9%. Sustained for total of 45 months. Cost savings of G637/corneal injury prevented Intervention: eyes lubricated with aqueous based gel and two clear occlusive dressing applied after tracheal intubation

Yu, H. D., Chou, A. H., Yang, M. W., & Chang, C. J. (2010). An analysis of perioperative eye injuries after nonocular surgery. *Acta Anaesthesiologica*, *48*(3), 122-129. https://doi.org/10.1016/S1875-4597(10)60043-4	Purpose: to establish incidence and risk factors of CA No framework or model noted	Retrospective Case Control Level V	Single Hospital	75,120 cases of non-ocular surgery requiring general anesthesia, 17 eye injures (10/17 CAs)	SPSS statistical software, Quality Assurance Database of the Department of Anesthesiology	Low Incidence of CAs: 10/75,120 cases Prevention used at facility: adhesive taping of eyelids with/without petroleum-based ointment following induction. Tegaderm used instead of adhesive tape in those undergoing lateral/prone positioning, long duration of surgery, head/neck surgery. Only eye ointment applied if tape contraindicated due to procedure. Tape removed before emergence. Risk factors (eye injury overall, not specifically CA): longer duration of surgery, preoperative anemia, fiberoptic bronchoscope used for intubation, lateral/prone positioning, deliberate hypotension Use of Tegaderm during high risk cases could have contributed to decreased incidence in this study.

Note. ASA = American Society of Anesthesiologists; SRNA = Student Registered Nurse Anesthetist; CA = Corneal Abrasion; PACU = Post Anesthesia Care Unit; NSAIDS = Non-Steroidal Anti-inflammatory Drugs; FiO2 = Fraction of Inspired Oxygen; min. = minutes; QI = Quality Improvement; N/A = Not Applicable; RP = Radical Prostatectomy; L/HYST = Laparoscopic Hysterectomy; O/HYST = Open Hysterectomy; IOP = Intraocular Pressure. Levels of Evidence from *Evidence-based practice in nursing and healthcare: A guide to best practice* (4th ed.), by B. M. Melnyk and E. Fineout-Overholt, 2019, p. 131. Copyright 2019 by Wolters Kluwer.

Appendix D

Organizational Approval Forms

ECU

Click "download PDF" to save a copy of this page for your records.
Note: The IRB Office does not maintain copies of your responses.

Below is a summary of your responses

Download PDF

Quality Improvement/Program Evaluation Self-Certification Tool

Purpose:
Projects that do not meet the federal definition of human research pursuant to 45 CFR 46 do not require IRB review. This tool was developed to assist in the determination of when a project falls outside of the IRB's purview.

Instructions:
Please complete the requested project information, as this document may be used for documentation that IRB review is not required. Select the appropriate answers to each question in the order they appear below. Additional questions may appear based on your answers. If you do not receive a STOP HERE message, the form may be printed as certification that the project is "not research", and does not require IRB review. The IRB will not review your responses as part of the self-certification process. For projects being done at Vidant Health, site support will be required. Please email crg.quality@vidanthealth.com to obtain site support from Vidant Health.

Name of Project Leader:

Luke Matthews

Project Title:

Assessing the Adequacy of a Newly Developed Corneal Abrasion Prevention Handout in High Risk Cases (Spinal Surgeries) at A Large Academic Medical Center

Brief description of Project/Goals:

Description of Project/Goals: The purpose of this project is to assess CRNA's preferences for corneal abrasion prevention as well as their perception of adequacy of this quick reference guide as it pertains to eye protection. The purpose of this quality improvement project is to assess anesthesia providers' perceptions of adequacy of a newly developed Perioperative Corneal Abrasion Prevention Guide. Process: A Quick-Reference Perioperative Corneal Abrasion Prevention Guide, based upon a comprehensive literature review, will be developed. Anesthesia providers at [redacted] will be asked several questions (through Qualtrics) about their perceptions of the adequacy of the currently used perioperative corneal abrasion prevention techniques and preparedness for corneal abrasion prevention. An educational video about the use of the newly developed Perioperative Corneal Abrasion Prevention Guide will be made available to them, and they will be asked to use the tool for two weeks. Upon completion of the two-week utilization, they will be asked to complete a questionnaire about their perceptions of the adequacy of the tool. Qualtrics survey software will be used to deliver the intervention link and gather participant perceptions of acceptability and adequacy of the intervention prior to and post implementation of the project. No patient information will be recorded or maintained during this project.

Will the project involve testing an experimental drug, device (including medical software or assays), or biologic?

○ Yes
● No

Has the project received funding (e.g. federal, industry) to be conducted as a human subject research study?

○ Yes
● No

Is this a multi-site project (e.g. there is a coordinating or lead center, more than one site participating, and/or a study-wide protocol)?

○ Yes
● No

Is this a systematic investigation designed with the intent to contribute to generalizable knowledge (e.g. testing a hypothesis; randomization of subjects; comparison of case vs. control; observational research; comparative effectiveness research; or comparable criteria in alternative research paradigms)?

○ Yes
● No

Will the results of the project be published, presented or disseminated outside of the

institution or program conducting it?

- [x] Yes
- [ ] No

Would the project occur regardless of whether individuals conducting it may benefit professionally from it?

- [x] Yes
- [ ] No

Does the project involve "no more than minimal risk" procedures (meaning the probability and magnitude of harm or discomfort anticipated are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests)?

- [x] Yes
- [ ] No

Is the project intended to improve or evaluate the practice or process within a particular institution or a specific program, and falls under well-accepted care practices/guidelines?

- [x] Yes
- [ ] No

Based on your responses, the project appears to constitute QI and/or Program Evaluation and IRB review is not required because, in accordance with federal regulations, your project does not constitute research as defined under 45 CFR 46.102(d). If the project results are disseminated, they should be characterized as QI and/or Program Evaluation findings. Finally, if the project changes in any way that might affect the intent or design, please complete this self-certification again to ensure that IRB review is still not required. Click the button below to view a printable version of this form to save with your files, as it serves as documentation that IRB review is not required for this project. 11/9/2021

Center for Research & Grants [redacted]

Quality Assurance/Quality Improvement Project vs. Human Research Study (Requiring IRB approval) Determination Form

This worksheet is a guide to help the submitter to determine if a project or study is a quality assurance/quality improvement (QA/QI) project or research study and is involving human subjects or their individually identifiable information and requires IRB approval as defined by the Health and Human Services (HHS) or Food and Drug Administration (FDA). Once completed, please email the form to the [redacted] Center for Research and Grants [redacted] A CRG team member will contact you with the results of their review and may request additional information to assist with their determination. The determination will be made in conjunction with the UMCIRB office.

Please contact the [redacted] with any questions a[redacted] or [redacted]

For more guidance about whether the activity meets the definition of Human Subjects Research see https://rede.ecu.edu/umcirb/irb-faqs/definitions/ or https://www.hhs.gov/ohrp/regulations-and-policy/decision-charts-2018/index.html#c1

Project Title: Assessing the Adequacy of a Newly Developed Corneal Abrasion Prevention Guide in High Risk Cases (Spinal Surgeries) at A Large Academic Medical Center		
Funding Source: None		
Project Leader Name: Luke Matthews/Maura McAuliffe	☐ Ed.D. ☐ J.D. ☐ M.D. ☐ Ph.D. ☐ Pharm.D. ■ R.N. ☐ Other(specify):	
Job Title: SRNA/ECU CRNA Faculty	**Phone:** [redacted]	**Email:** mcauliffem@ecu.edu
	Primary Contact (If different from Project Leader): Luke Matthews	
	Phone: [redacted]	**Email:** matthewsl11@students.ecu.edu

Key Personnel/ Project Team members:

Name and Degree:	Department: (Affiliation if other than Vidant)	Email:
Luke Matthews, SRNA	ECU Nurse Anesthesia Program	matthewsl11@students.ecu.edu
Maura McAuliffe, PhD, CRNA (Project Chair)	ECU Nurse Anesthesia Program Director/Project Chair	mcauliffem@ecu.edu

QI/QA Assessment Checklist:

Consideration	Question	Yes	No
PURPOSE	Is the PRIMARY purpose of the project/study to: • IMPROVE care right now for the next patient? OR • IMPROVE operations outcomes, efficiency, cost, patient/staff satisfaction, etc.?	✔	
RATIONALE 1	The project/study falls under well-accepted care practices/guidelines or is there sufficient evidence for this mode or approach to support implementing this activity or to create practice change, based on: • literature • consensus statements, or consensus among clinician team	✔	
RATIONALE 2	The project/study would be carried out even if there was no possibility of publication in a journal or presentation at an academic meeting. (**Please note that answering "Yes" to this statement does not preclude publication of a quality activity.)	✔	
METHODS 1	Are the proposed methods flexible and customizable, and do they incorporate rapid evaluation, feedback and incremental changes?	✔	
METHODS 2	Are patients/subjects randomized into different intervention groups in order to enhance confidence in differences that might be obscured by nonrandom selection? (Control group, Randomization, Fixed protocol Methods)		✔
METHODS 3	Will there be delayed or ineffective feedback of data from monitoring the implementation of changes? (For example to avoid biasing the interpretation of data)		✔
METHODS 4	Is the Protocol fixed with fixed goal, methodology, population, and time period?		✔
RISK	The project/study involves no more than minimal risk procedures meaning the probability and magnitude of harm or discomfort anticipated are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.	✔	
PARTICIPANTS	Will the project/study only involve patients/subjects who are ordinarily seen, cared for, or work in the setting where the activity will take place?	✔	
FUNDING	Is the project/study funded by any of the following? • An outside organization with an interest in the results • A manufacturer with an interest in the outcome of the project relevant to its products • A non-profit foundation that typically funds research, or by internal research accounts		✔

If all of the check marks are inside the shaded gray boxes, then the project/study is very likely QI and not human subject research. Projects that are not human subject research do not need review by the IRB.

rev. 03.21

In order to assess whether your project meets the definition of human subject research requiring IRB review or may qualify as a quality improvement/assurance activity, please provide the following information:

1. **Project Summary: In the space provided below, please provide a summary of the purpose and procedures.**

   A corneal abrasion quick reference guide based upon national guidelines will be utilized to guide anesthesia providers' perioperative eye care. Anesthesia providers at [redacted] will be asked several questions (through Qualtrics) about their perceptions of the adequacy of their current eye care practices during general anesthesia. A PowerPoint presentation about the use of the corneal abrasion quick reference guide will then be made available to them, and they will be asked to use the corneal abrasion quick reference guide for two weeks. Upon completion of the two-week utilization period, Qualtrics survey software will be used to gather anesthesia providers' perceptions of acceptability and adequacy of the corneal abrasion quick reference guide. No patient information will be recorded or maintained during this project.

2. **If the Primary purpose of your project/study is for QA/QI, have you obtained approval from the operational leader within your department or health system** [Please specify here whom and obtain their signature in the signature section below]: Dewayne Byrd, MSN, CRNA

   [redacted] **Yes**

   [redacted] **No** [Contact the appropriate operational leader for approval.]

Please note:

- By submitting your proposed project/study for QA/QI determination you are certifying that if the project/study is established to qualify as QA/QI project, you and your Department would be comfortable with the following statement in any publications regarding this project: "This project was reviewed and determined to qualify as quality improvement by the [redacted] Research and Grants."
- If you are submitting a Poster to Media Services for printing, you will need to also submit this Quality Improvement Worksheet or proof of your IRB Application and IRB Approval.
- If the [redacted] determines the activity is not human subject research, then any presentation, publication, etc. should not refer to the activity as "human subject research," "exempt research," or "expedited research."
- If you would like the [redacted] to verify that a project/study is not human subject research, please provide this form completed with the summary of your activity and any additional information to the [redacted] at [redacted] and the following will be completed and returned to you for your records.

NHSR vs. HSR Determination:

☐ **Not Human Subject Research:** The [redacted] has determined that based on the description of the project/study, approval by the IRB is not necessary. Any changes or modifications to this project may be discussed with the [redacted] at that time to ensure those changes do not elevate the project to human research that would need IRB approval.
☐ **Human Subject Research:** This project/study requires review by the IRB prior to initiation. An application in the electronic IRB submission system should be submitted.

Approval Signatures:

[redacted] Operational Mgr/Leader: [redacted] Date: 3-7-2022

[redacted] Reviewer: _____ Date: _____

UMCIRB Office Staff Reviewer: _____ Date: _____

Attestation of Understanding

My signature below indicates that I fully understand that HIPAA Privacy standards as they apply to Quality Projects involving Protected Health Information and patient medical records as outlined below.

Under HIPAA's minimum necessary provisions, [redacted] must make reasonable efforts to limit PHI to the minimum necessary to accomplish the purpose of the use, disclosure or request.

Under HIPAA, a Covered Entity [redacted] can disclose PHI to another CE [redacted] for the following subset of health care operations activities of the recipient CE without needing patient consent:

- Conducting quality assessment and improvement activities
- Developing clinical guidelines
- Conducting patient safety activities as defined in applicable regulations
- Conducting population-based activities relating to improving health or reducing health care cost

[redacted] healthcare data utilized in this project should not be shared outside of the CE without a fully executed data use/sharing agreement. [redacted] leadership reserves the opportunity to review all articles for dissemination/ publication for which [redacted] data has been utilized.

L Martin
Project Leader Signature

2/14/22
Date

Appendix E

Corneal Abrasion Quick Reference Guide

ECU

Intraoperative Corneal Abrasion Prevention

Maura McAuliffe PhD, CRNA, FAAN, Project Chair
Christopher Chukala BSN, RN, SRNA
Justin Grady BSN, RN, SRNA
Luke Matthews BSN, RN, SRNA
Savannah Samuel BSN, RN, SRNA

Risk Factors:

- Advanced Age[1,2,3,6]
- SRNA as provider[1,5]
- Head and neck surgery[2,5]
- Graves' disease/exophthalmos[2,5]
- Lateral/prone/trendelenburg position[1,2]
- Prolonged surgery duration > 3.5 hours[6]
- Robotic surgery cases[6]
- Diabetes[1]
- Low ASA status[1]

Incidence/Litigation

- One of the most common malpractice cases (4%)
- 2% of all malpractice claims
- Incidence of CAs 0.64% overall[6]
- CAs account for 35% of all ocular injury claims and awards for ocular injuries are 4% higher than any other claim[6]

Sources of CAs:

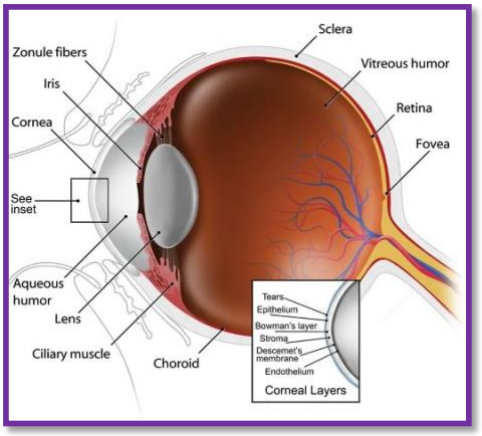
- Identification badges[1, 4]
- Stethoscopes[1]
- Laryngoscopes[1,4]
- Oxygen facemasks[1,2,4]
- Pulse oximeter probe on dominant hand[1,2,4]
- Watch band[2,4]
- Surgical drapes[2,4]
- Bair hugger[2]

Pathophysiology

- Corneal abrasions are superficial injuries to the epithelial layer of the cornea that cause pain, photophobia, excessive tearing, headache, and blurry vision.
- They normally heal within 72 hours but cause patients extensive, unanticipated discomfort in addition to their post-operative pain[2,4]
- One fifth of these injuries occur from mechanical trauma such as scratching the eyes post-surgery or from objects such as oxygen masks, badges, and surgical drapes as well as chemical injuries from substances such as antiseptics[2]. Other factors that add to the risk of corneal abrasions are foreign bodies, contact lens, and dry eyes[2].
- During general anesthesia, contraction of the orbicularis oculi muscle is inhibited therefore putting patients at increased risk for corneal abrasions due to insufficient closing of the eyelid and subsequent drying of the cornea[2].
- General anesthesia also inhibits blink reflexes, tear production, and what is known as Bell's phenomenon.
    - Bell's phenomenon is the upward and outward movement of the globe when the eyes close. The cornea stays more exposed during a threat without this reflex intact, contributing to injury.

Assessment and Diagnosis

- Initial assessment and treatments can be completed by an anesthesiologist
- Abrupt onset of eye pain, blurry vision, photophobia, excessive tearing, foreign body sensation within 2 hours of procedure[2,4]
- R/o foreign body: evert eyelids to assess for any foreign body. If foreign body present irrigate with topical anesthetic[2,4]
- Assess visual acuity, EOMs, pupil reactivity[4]
- Definitive diagnosis: fluorescein staining reveals yellow green staining of basement membrane in presence of corneal abrasion[2,4]

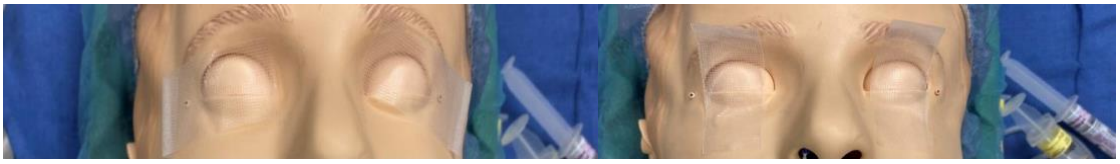


ECU

Intraoperative Corneal Abrasion Prevention

Maura McAuliffe PhD, CRNA, FAAN, Project Chair
Christopher Chukala BSN, RN, SRNA
Justin Grady BSN, RN, SRNA
Luke Matthews BSN, RN, SRNA
Savannah Samuel BSN, RN, SRNA

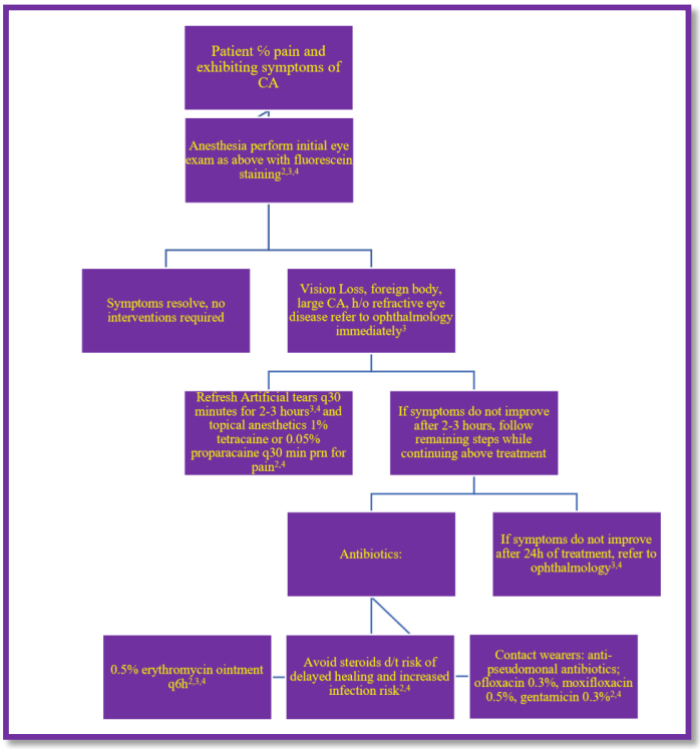
How do you tape your patients' eyes shut? Horizontal vs Vertical?



Interventions

- Secure eyelids with tape immediately after loss of lid reflex on induction and prior to securing the airway (Sundar)
  - The tape should be placed horizontally across the entire lid line. (Sundar, Grixti)
  - Use of Tegaderm to secure eyes in high risk cases[1,4] Tegaderm is water-tight and can prevent chemical injury with surgical prep solutions on the face[2]
- Use preservative-free 4% methylcellulose-based ointment to lubricate the eyes when taping is undesirable[1,4]
- Paraffin based lubricant can absorb highly soluble anesthetics like Halothane and cause irritation[1]
- Petroleum ointments are flammable - avoid with high FiO2 and electrocautery near the face[2]
- Remove tape from upper to lower lid to reduce risk of mechanical trauma[2]

Stepwise Treatment Protocol



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Appendix F

Pre-Intervention Survey

1. Have you or do you know of a colleague that has personally been involved in the care of a patient who had a corneal abrasion?
    a. Yes
    b. No

2. If you or a colleague were involved in the care of a patient who had a corneal abrasion, what was the cause of the injury? Please select all that apply.
    a. Patient rubbing eyes upon emergence/recovery
    b. Tape or eye protection inadvertently removed during procedure
    c. Manual trauma from equipment such as stethoscope, ID badges, pulse ox probe, drapes, robotic surgical equipment
    d. Chemical trauma spilled into the eye such as surgical prep used in the facial area
    e. Other (comment)

3. What prevention measures do you routinely implement for eye protection during a **standard induction** of general anesthesia (checklist)?
    a. None
    b. Eye goggles/shield
    c. Tegaderm
    d. Clear tape
    e. Paper tape
    f. Lubricant (VMC uses "Systane" 3% mineral oil and 94% white petroleum)
    g. Tape/tegaderm in combination with lubricant
    h. Other (comment)

4. What prevention measures do you implement for eye protection in patients and/or surgeries that you identify to be at **high risk** for corneal abrasions?
    a. None
    b. Eye goggles/shield
    c. Tegaderm
    d. Clear tape
    e. Paper tape
    f. Eye lubricant (VMC uses "Systane" 3% mineral oil and 94% white petroleum)
    g. Tape/tegaderm in combination with lubricant
    h. Other (comment)

5. Please comment to indicate any additional prevention measures not listed above that you take to protect patients from corneal abrasion. Suggested examples: placing pulse oximeter probe on the non-dominant hand, removing stethoscope or identification badges from the immediate area prior to intubation, vigilance strategies to prevent patient from rubbing the eyes during transport, additional foam padding around the patient's eyes during high risk cases)
    a. None
    b. (Comment)

6. When do you routinely tape the eyes during a **standard induction** of general anesthesia?

a. Before securing the airway
b. After securing the airway

7. What types of surgery, patient positioning, and patient demographic/co-morbid conditions would you consider as **high risk** for perioperative corneal abrasions? (open ended question with an answer box for surgery, position, and demographic/co-morbid conditions)

8. During general anesthesia, how often do you routinely assess the eyes for protection from corneal abrasions? (Select all that apply)
    a. Never
    b. Every 15 minutes
    c. Every 30 minutes
    d. During position changes
    e. During emergence

9. Please rate your confidence in your ability to **identify patients at high risk** for corneal abrasions.
    a. Not confident
    b. Slightly confident
    c. Somewhat confident
    d. Fairly confident
    e. Highly confident

10. Please rate your confidence in your ability to **take appropriate measures to prevent corneal abrasions**.
    a. Not confident
    b. Slightly confident
    c. Somewhat confident
    d. Fairly confident
    e. Highly confident

11. Please rate your confidence in your ability to **assess, diagnose, and treat corneal abrasions**.
    a. Not confident
    b. Slightly confident
    c. Somewhat confident
    d. Fairly confident
    e. Highly confident

Post-Intervention Survey

1. During the past two weeks have you been involved in any surgical cases where a corneal abrasion occurred?
    a. Yes
    b. No

2. During the past two weeks how many surgical cases did you identify as **high risk** for corneal abrasions?
    a. 0
    b. 1-5
    c. 6-10
    d. 11-15
    e. > 15

3. During the past two weeks did you perceive the CA quick reference guide to be useful for your practice to prevent corneal abrasions? Please comment why if so.
    a. Yes (comment)
    b. No

4. How likely are you to utilize the CA quick reference guide in the future to implement additional eye protective strategies in your practice?
    a. Highly unlikely
    b. Unlikely
    c. Neutral
    d. Likely
    e. Highly likely

5. After this intervention, have you made any changes to your practice to prevent corneal abrasions? Please comment on what you may have changed.
    a. Yes (comment)
    b. No

6. Are there other eye protection strategies not listed on the CA quick reference guide that you would see as beneficial for others to know?
    a. Yes (comment)
    b. No

7. How strongly do you agree or disagree with the following statement: After viewing the PowerPoint presentation and using the CA quick reference guide for the past two weeks, my awareness for the potential of perioperative corneal abrasion has increased.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly agree

8. In the future, if an Epic shortcut was created to allow for streamlined documentation of eye care strategies utilized during the case, would that be beneficial to you?

a. Yes
b. No

9. After having access to this CA quick reference guide, please rate your confidence in your ability to **identify patients at high risk** for corneal abrasions.
    a. Not confident
    b. Slightly confident
    c. Somewhat confident
    d. Fairly confident
    e. Highly confident

10. After having access to this CA quick reference guide, please rate your confidence in your ability to **take appropriate measures to prevent corneal abrasions**.
    a. Not confident
    b. Slightly confident
    c. Somewhat confident
    d. Fairly confident
    e. Highly confident

11. After having access to this CA quick reference guide, please rate your confidence in your ability to **assess, diagnose, and treat corneal abrasions**.
    a. Not confident
    b. Slightly confident
    c. Somewhat confident
    d. Fairly confident
    e. Highly confident

12. Please comment on any potential barriers to the use of the CA quick reference guide and/or implementation of eye protection strategies at your facility. (Open ended)

Appendix G

Initial Pre-Intervention Survey and PowerPoint Presentation Email

Dear [partnering institution] CRNAs,

Thank you for considering participation in my quality improvement project titled "Assessing the Adequacy of a Newly Developed Corneal Abrasion Prevention Guide in High-Risk Cases (Spinal Surgeries) at A Large Academic Medical Center." The purpose of this quality improvement project is to assess CRNAs' preferences and practices regarding eye care and corneal abrasion prevention and whether or not you perceive the corneal abrasion quick reference guide as a useful tool in your practice to prevent corneal abrasions.

Your participation is completely voluntary, but much appreciated, as it will serve to instruct my learning as I work to obtain skills in performing a quality improvement project. Your participation will involve completing a short pre-intervention survey, viewing a brief PowerPoint presentation, and utilizing a corneal abrasion (CA) quick reference guide in your practice for two weeks. At the end of the two-week implementation period, you will be asked to complete a short post-intervention survey regarding the use of the corneal abrasion quick reference guide.

Each survey and the PowerPoint presentation should take less than 10 minutes to complete. The questionnaires were created and are completed using Qualtrics® survey software. The corneal abrasion quick reference guide was developed based on a current review of the literature and falls within the currently accepted practice in your work area. Your participation is voluntary and responses will be kept confidential. The results of this QI study will be shared with you upon completion.

How to Participate

1. Complete the pre-intervention survey: xxx
2. View a short PowerPoint presentation attached to this email outlining the use of the corneal abrasion quick reference guide.
3. Utilize the corneal abrasion quick reference guide attached to this email in your practice for two weeks.

Again, thank you for your participation in this quality improvement project. I will be present at [redacted] Medical Center in the main operating room during the 2 week period but you may also reach out to me or [Project Chair] by email if you have any questions.

Pre-Survey and PowerPoint presentation Reminder Email

Hello [partnering institution] CRNAs,

I just wanted to send out a quick reminder about the ongoing DNP Project on corneal abrasion prevention. If you have already filled out the pre-intervention survey and viewed the PowerPoint presentation, thank you! If you haven't had a chance yet, it's not too late to participate and would be very helpful and much appreciated. You can still access the pre-intervention survey through the link below and PowerPoint presentation and the corneal abrasion quick reference guide attached to this email. After the end of the next week, I will begin sending out the post-intervention surveys.

Links:
Pre-Intervention Survey: xxx
PowerPoint presentation attached to this email
Corneal Abrasion Quick Reference Guide attached to this email

Please let me know if you have any questions and thank you again for your participation.

Post-Intervention Survey Email to Participants

Dear [partnering institution] CRNAs,

Thank you to everyone who has already completed the pre-intervention survey, viewed the PowerPoint presentation, and utilized the corneal abrasion quick reference guide for the last two weeks. It's now time to complete the brief post-intervention survey.

If you have not filled out a pre-intervention survey, I would really and truly appreciate your participation. You can still access and complete the pre-intervention survey and view the PowerPoint presentation attached to this email. The corneal abrasion quick reference guide is also attached to this email for your reference.

If you have already completed the pre-intervention survey, it would be great if you could also complete the post-intervention survey. The survey should take less than 5 minutes to complete.

Survey Links:
Pre-Intervention Survey: xxx
Post-Intervention Survey: xxx

If anyone has questions or issues with the links, please reach out to me via email. Again, thank you for your participation in this quality improvement project. You have helped me develop skills in performing a QI project in addition to developing effective skills as an anesthesia provider. I look forward to continuing to learn from you all!

Final Thank You Email to Participants

Dear [partnering institution] CRNAs,

I just wanted to say thank you so much for your help in completing my DNP Project. I have collected all the data that I need to proceed with data analysis and will then be finished with my paper. Once it's complete you all will be able to read it if you would like. If you liked the corneal abrasion quick reference guide, and found it to be useful, you can continue to use it in your practice and feel free to share it with other anesthesia providers. You can find a copy attached to this email for your future use.

Thank you again! I look forward to continuing to learn from you all in the future.

Appendix H

PowerPoint Presentation and Recording Script

Introduction

Modern developments in delivery of anesthesia have provided an avenue of endless opportunities for the medical field, often enabling clinicians to perform life-saving procedures that would have never been possible before. However, rendering a person unconscious and altering their autonomic responses comes with its vulnerabilities and risks. A common risk associated with anesthesia is the potential for occurrence of perioperative eye injuries. Although information exists regarding the prevention of perioperative eye injuries, standards of care regarding these injuries often lack clarity or are overlooked. The purpose of this quality improvement project was to assess CRNAs' knowledge, preferences, and practices regarding eye care and corneal abrasion prevention and whether or not they perceived a corneal abrasion quick reference guide as a useful tool for their practice to prevent corneal abrasions.

Pathophysiology

Corneal abrasions are superficial injuries to the epithelial layer of the cornea that cause pain, photophobia, excessive tearing, headache, blurry vision, and occasionally infections. They normally heal within 72 hours but cause patients extensive, unanticipated discomfort in addition to their post-operative pain. One fifth of these injuries occur from mechanical trauma such as scratching the eyes post-surgery or from objects such as oxygen masks, badges, and surgical drapes as well as chemical injuries from substances such as antiseptics Other factors that add to the risk of corneal abrasions are foreign bodies, contact lens, and dry eyes. During general anesthesia, contraction of the orbicularis oculi muscle is inhibited therefore putting patients at increased risk for corneal abrasions due to insufficient closing of the eyelid and subsequent drying of the corneal. General anesthesia also inhibits blink reflexes, tear production, and what is known as Bell's phenomenon. Bell's phenomenon is the upward and outward movement of the globe when the eyes close. The cornea stays more exposed during a threat without this reflex intact, contributing to injury

Assessment and Diagnosis

Early assessment and diagnosis is crucial in mitigating the impact of corneal abrasions on patient comfort and satisfaction. If a patient suddenly complains of abrupt eye pain, blurry vision, photophobia, excessive tearing, or a foreign body sensation within two hours of a procedure, a corneal abrasion should be suspected. To rule out the presence of a foreign body, the eyelids should be everted and thoroughly inspected. If a foreign body is present, irrigate with a topical anesthetic. Assessments of visual acuity, extraocular movements, and pupil reactivity should also be performed. To definitely diagnose a corneal abrasion, fluorescein staining is required. In the presence of a corneal abrasion the basement membrane will present as a yellow green stain.

Prevention of Corneal Abrasion and Risk Factors

Risk factors of corneal abrasions include

- Advanced age
- head/neck and robotic surgery
- Duration of surgery >3.5 hours
- Diabetes
- Patient position -lateral/prone/trendelenburg - lateral and prone having the highest risk
- Exopthalmos

Some of the sources of corneal abraions include the anesthesia provider, badges, stethoscopes, O2 masks, pulse ox's, chemicals, drapes, bair huggers, surgical instruments being placed on the patient head

There are no established standards of care for perioperative corneal abrasion prevention. But prevention methods of corneal abrasion that were noted in the literature include the taping of the eyes, lubricants versus eye ointments and preservative free versus paraffin ointments. Additionally, educating anesthesia providers to tape the eyes immediately after loss of lash reflex is an effective method as well.
Types of tape include medipore, paper tape, tegaderm, or the protective eye goggles.
Types of ointments include, paraffin (petroleum) based versus water based. Paraffin have been associated with blurred vision, allergic reactions, photophobia and foreign body sensation.

Treatment Algorithm

As you know, CAs can cause intense pain and prompt treatment is necessary. Delay in treatment can result in patient dissatisfaction as well as prolonged PACU stay. Anesthesiology led treatment protocols have been successful in managing simple CAs and have demonstrated less time to treatment compared to ophthalmology consult. We synthesized current literature regarding anesthesiology led treatment of CAs and developed the treatment algorithm that you see here. After the patient complains of eye pain, anesthesiology should immediately assess the patient's eyes to include fluorescein staining if needed. If symptoms resolve spontaneously, no intervention is required. If the patient has history of eye disease, vision loss has occurred, foreign body is present, or it is a large CA, we recommend referring the patient to ophthalmology immediately. However, if none of the above are the case, treatment should focus on management of pain and prevention of infection. Refresh artificial tears can be used every 30 minutes for 2-3 hours. Topical anesthetics such as 1% tetracaine or 0.05% proparacaine should be used every 30 minutes as needed for pain. If symptoms do not improve after the initial 2-3 hours, prevention of infection becomes important. 0.5% Erythromycin every 6 hours should be the first line of treatment. Patients who wear contacts are susceptible to gram negative pseudomonas infections and should be treated with ofloxacin, moxifloxacin, or gentamicin. Steroids should be avoided as they could lead to delayed healing and increased risk of infection. Treatment by the anesthesiology team should be limited to 24 hours to prevent masking of pain associated with a worsening condition. If symptoms persist after 24 hours of treatment, the patient should be referred to ophthalmology for further management.


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By Savannah Samuel, Chris Chukala, Justin Grady, and Luke Matthews

Justin Grady

Luke Matthews

Chris Chukala

Savannah Samuel

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Introduction to our Project

- A common risk associated with anesthesia is the potential for occurrence of perioperative eye injuries.
- Information exists regarding the prevention of perioperative eye injuries, but standards of care regarding these injuries often lack clarity or are overlooked.
- We focused on the most common intraoperative injury, corneal abrasions.

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Pathophysiology

- Corneal Abrasions are superficial injuries to the epithelial layer of the cornea that cause pain, photophobia, excessive tearing, headache, blurry vision, and occasionally infections.
- They normally heal within 72 hours but cause patients extensive, unanticipated discomfort in addition to their post-operative pain.
- Often happen without knowledge due to contact with the cornea while the patient is anesthetized

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Assessment and Diagnosis

- If a patient suddenly complains of abrupt eye pain, blurry vision, photophobia, excessive tearing, or a foreign body sensation within two hours of a procedure, a corneal abrasion should be suspected.

- To rule out the presence of a foreign body, the eyelids should be everted and thoroughly inspected.
- To definitively diagnose a corneal abrasion, fluorescein staining is required.
  - Yellow green stain will occur

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Prevention

- Know the risk factors!
  - Advanced age, head, neck and robotic surgery, surgery duration > 3.5 hours, diabetes, lateral, prone or Trendelenburg position, exophthalmos
- Sources
  - Badges, stethoscopes, oxygen masks, pulse oximeter on dominant hand, chemicals, drapes or bair huggers
- Secure eyelids with tape immediately after loss of lid reflex on induction and prior to securing the airway
  - Horizontal, tegaderm in high risk cases

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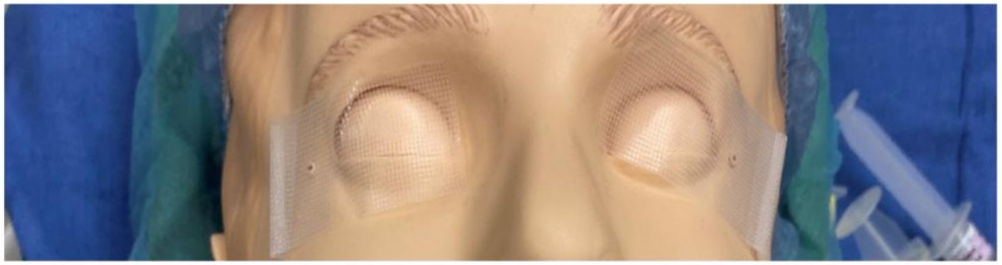
Prevention (continued)

- Use preservative-free 4% methylcellulose-based ointment to lubricate the eyes when taping is undesirable
- Remove tape from upper to lower lid to reduce risk of mechanical trauma



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Treatment

- Delay in treatment can result in patient dissatisfaction as well as prolonged PACU stay.
- Refresh artificial tears can be used every 30 minutes for 2-3 hours.
- Topical anesthetics such as 1% tetracaine or 0.05% proparacaine should be used every 30 minutes as needed for pain.
- If symptoms do not improve after the initial 2-3 hours, prevention of infection becomes important. 0.5% Erythromycin every 6 hours should be the first line of treatment.
- If the patient has history of eye disease, vision loss has occurred, foreign body is present, it is a large CA, or symptoms persist after 24 hours of treatment, refer patient to ophthalmology

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Purpose of our Project

- The purpose of this quality improvement project was to assess CRNAs' knowledge, preferences, and practices regarding eye care and corneal abrasion prevention and whether or not they perceived a corneal abrasion quick reference guide as a useful tool for their practice to prevent corneal abrasions.
- We are asking for your help!
- We have provided a quick reference guide to aid your practice
- Take the pre survey provided through email, utilize the guide for two weeks, then take the post survey afterward

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ECU Intraoperative Corneal Abrasion Prevention

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Savannah Samuel BSN, RN, SRNA

Risk Factors:

- Advanced Age[1,2,3,4]
- SRNA as provider[1,5]
- Head and neck surgery[2,3]
- Graves' disease/exophthalmos[2,3]
- Lateral/prone/trendelenburg position[1,2]
- Prolonged surgery duration > 3.5 hours[4]
- Robotic surgery cases[4]
- Diabetes[1]
- Low ASA status[1]

Incidence/Litigation

- One of the most common malpractice cases (4%)
- 2% of all malpractice claims
- Incidence of CAs 0.64% overall[6]
- CAs account for 35% of all ocular injury claims and awards for ocular injuries are 4% higher than any other claim[6]

Sources of CAs:

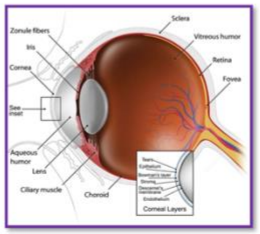
- Identification badges[1,4]
- Stethoscopes[1]
- Laryngoscopes[1,4]
- Oxygen facemasks[1,2,4]
- Pulse oximeter probe on dominant hand[1,2,4]
- Watch band[2,4]
- Surgical drapes[2,4]
- Bair hugger[2]

Pathophysiology

- Corneal abrasions are superficial injuries to the epithelial layer of the cornea that cause pain, photophobia, excessive tearing, headache, and blurry vision.
- They normally heal within 72 hours but cause patients extensive, unanticipated discomfort in addition to their post-operative pain[2,4]
- One fifth of these injuries occur from mechanical trauma such as scratching the eyes post-surgery or from objects such as oxygen masks, badges, and surgical drapes as well as chemical injuries from substances such as antiseptics[2]. Other factors that add to the risk of corneal abrasions are foreign bodies, contact lens, and dry eyes[2].
- During general anesthesia, contraction of the orbicularis oculi muscle is inhibited therefore putting patients at increased risk for corneal abrasions due to insufficient closing of the eyelid and subsequent drying of the cornea[2].
- General anesthesia also inhibits blink reflexes, tear production, and what is known as Bell's phenomenon.
  - Bell's phenomenon is the upward and outward movement of the globe when the eyes close. The cornea stays more exposed during a threat without this reflex intact, contributing to injury.

Assessment and Diagnosis

- Initial assessment and treatments can be completed by an anesthesiologist
- Abrupt onset of eye pain, blurry vision, photophobia, excessive tearing, foreign body sensation within 2 hours of procedure[2,4]
- R/o foreign body: evert eyelids to assess for any foreign body. If foreign body present irrigate with topical anesthetic[2,4]
- Assess visual acuity, EOMs, pupil reactivity[4]
- Definitive diagnosis: fluorescein staining reveals yellow green staining of basement membrane in presence of corneal abrasion[2,4]



Front of Guide

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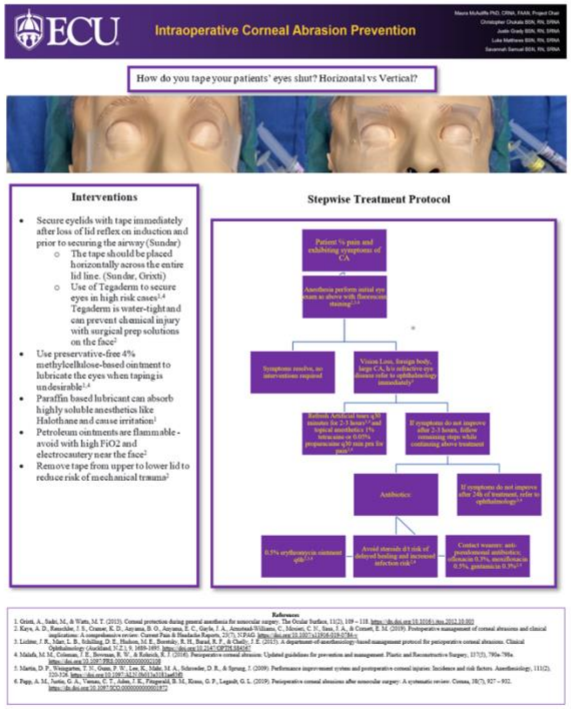

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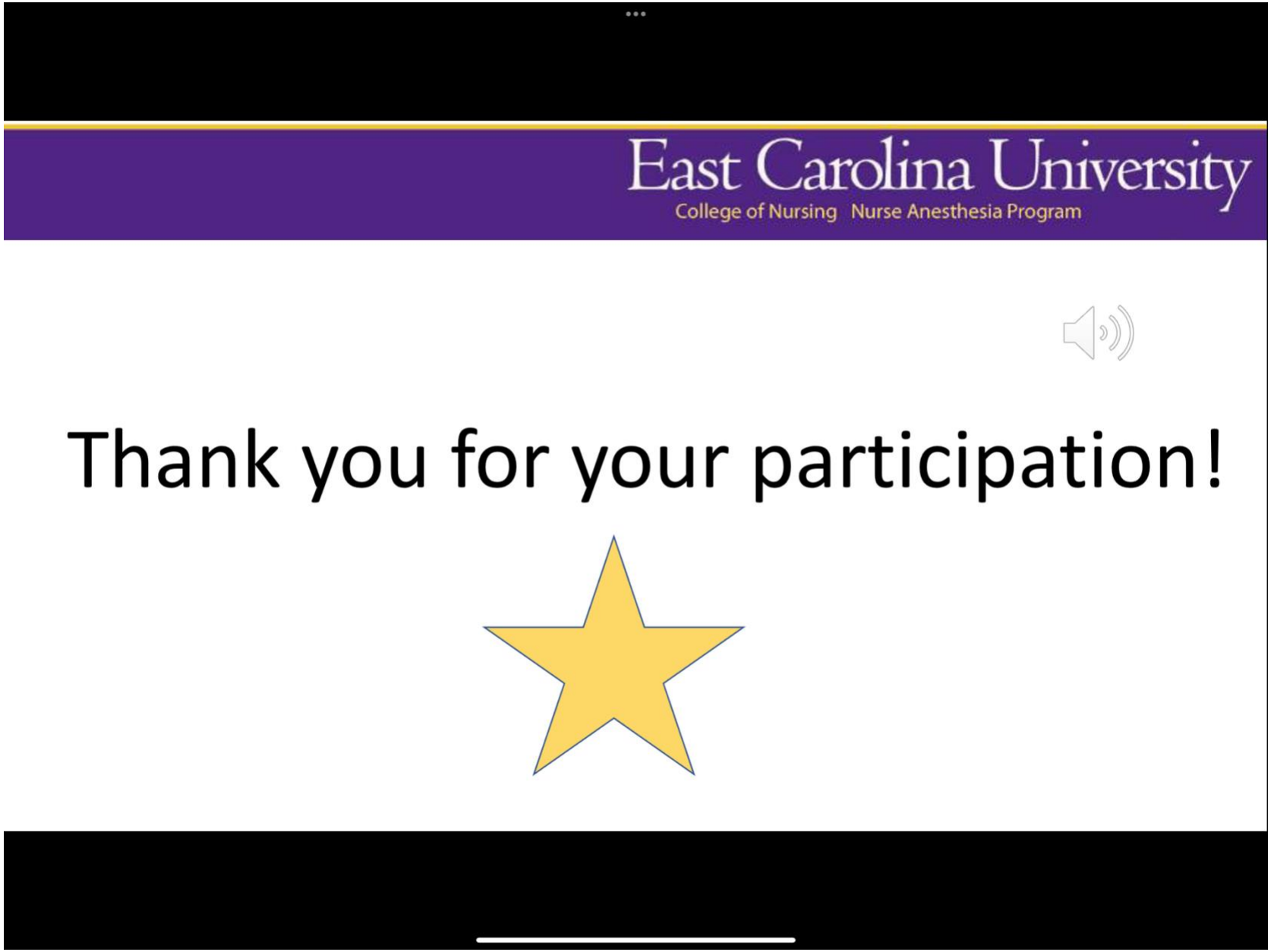
Back of Guide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Thank you for your participation!

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