Intraoperative Eye Protection for Prevention of Corneal Abrasion

by

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Abstract

Problem: Corneal abrasion (CA) is a common complication in patients undergoing general anesthesia (GA) for surgeries unrelated to the eyes. Patients undergoing GA can develop CA due to the loss of some physiologic eye-protective reflexes while under GA. The anesthesia department in a midsize community hospital noticed a 2% increase in the incidence of CA in perioperative patients who received GA for non-ocular surgeries. Evidence review confirms utilization of a CA prevention protocol as well as continuing education for anesthesia providers on CA prevention resulted in a decrease in CA in patients receiving GA. **Purpose**: This quality improvement (QI) initiative aims to educate anesthesia providers on CA prevention and promote provider adherence to an evidence-based intraoperative CA prevention guideline. **Method**: This QI project took place over 15 weeks, from September to December 2023. The intraoperative CA guideline was created by the project lead (PL) and approved by the site. The PL conducted an in-person education via PowerPoint presentation for all 25 full-time anesthesia providers during a staff meeting. Attendance was measured by the PL using the staff education survey completed by the providers. Compliance with the use of the guideline was measured using the CA guideline survey completed daily by anesthesia providers for all patients receiving GA. **Results**: The staff education survey was completed by 8% of anesthesia providers. 100% compliance was noted during the first week of implementation and the lowest compliance rate of 0% was noted on weeks 5 and 15, respectively. The median compliance rate for the guideline use dropped from 33 to 25 from weeks 11 through 15. **Conclusions:** A QI project implementing an intraoperative CA prevention guideline has great potential and feasibility for improving the quality of care delivered to patients and enhancing patient outcomes during the perioperative period.

Key Words: General Anesthesia, Corneal Abrasion, Quality Improvement

Intraoperative Eye Protection for Prevention of Corneal Abrasion

Corneal abrasion (CA) is a common complication in patients undergoing general anesthesia (GA) for surgeries unrelated to the eyes (Moos & Lind, 2006). CA refers to damage to the tissue lining of the cornea due to trauma or exposure of the eyes to air for a long period of time (Deljou et al., 2019). Patients undergoing GA are susceptible to developing CA since GA decreases the corneal reflex, tear production, and the ability to completely close the eyelids (Malafa et al., 2016; Roth et al., 1996).

A community hospital in Maryland, consisting of approximately 15 Certified Registered Nurse Anesthetists and 10 anesthesiologists, noticed recurrent cases of CA in perioperative patients who received GA for non-eye-related surgeries. Approximately 80 surgical procedures were performed weekly under GA at the site, and within 6 months, a 2% increase in the incidence of CA was noted in patients who received GA. CA not only causes great discomfort to patients but also affects patient satisfaction (Morris et al., 2018). With proactive treatment, perioperative CA usually resolve within a few days (Wipperman & Dorsch, 2013). However, in rare situations, it could result in severe complications such as corneal ulcers and infection (Porter et al., 2022).

A root cause analysis was conducted to determine factors contributing to the occurrence of CA in patients who received GA at the site of interest. Notable contributors to CA included the use of eye cosmetics such as false eyelashes during surgery, the lack of anesthesia providers' awareness of objects in proximity to patients' eyes, and delayed or ineffective eye protection. Figure 1 depicts a fishbone diagram illustrating factors contributing to CA at the target site. Independent observations of 20 anesthesia providers' workflow from induction to the emergence of GA were performed. Some anesthesia providers did not protect the patient's eyes before a direct laryngoscopy. Therefore, delayed eye protection was recognized as the major contributing factor for the development of CA. The purpose of this quality improvement (QI) project was to implement and evaluate the effectiveness of an intraoperative guideline supporting the prevention of CA in adult patients receiving GA for non-ocular surgery.

Available Knowledge

A literature review to identify evidence-based solutions to prevent CA was performed. Five studies evaluated different eye protective materials and their resulting effects on CA prevention, while two studies assessed the benefits of utilizing a CA prevention protocol. Yang et al. (2018) confirmed occlusive dressings offered protection against CA with or without the additional use of eye ointment. This data was inconsistent with Drzymalski et al.'s (2021) findings of comparable benefits in CA prevention with the use of either occlusive dressing or eyeglasses. Results from both studies conflicted with Wan et al. (2014) data, which recognized hydrogel as a superior form of eye protection compared to tape. Although variation existed in each study on the most effective method of eye protection, all three studies confirmed using eye protection decreases CA in patients receiving GA. Grixti et al. (2013) and Papp et al. (2019) had similar findings, confirming the use of tape as an effective method of eye protection during GA. However, Papp et al. (2019) further described bio-occlusive dressing as the most favorable form of eye protection during GA. Vetter et al. (2012) and Porter et al. (2022) explained the implementation of a CA prevention protocol, including methods of eye protection, could reduce the incidence of CA in patients receiving GA. The two studies also determined the implementation of a continuing education program focusing on training providers on CA prevention resulted in a decrease in CA.

The studies appraised consisted of three RCTs (levels 1B and C), two systematic reviews of RCTs and non-experimental studies (IIB and IIC), and two expert reports (IVA and B) based on the Johns Hopkins Nursing Evidence-Based Practice Evidence Level and Quality Guide (2017). Despite the varying levels of evidence from the appraised studies, there was good and consistent evidence to support a practice change. Appendix A and Appendix B illustrates the evidence review and synthesis.

Rationale

This QI project's development and implementation were guided by the framework of complex innovation described in Helfrich et al. (2007). This framework highlights seven inextricably intertwined factors contributing to the successful implementation of a new complex innovation. These factors are management support, availability of financial resources, innovation-value fit, champion, implementation of policies and procedures, implementation effectiveness, and implementation climate (Figure 2). The feasibility of successfully implementing this QI project was improved in consideration of these factors. Climate change was influenced by gaining the support of the department chair and sponsor. Additionally, support from champions and highly experienced anesthesia providers helped in achieving the process goals. Finally, collaboration with the anesthesia providers facilitated achieving the structural goals.

Methods

Context

Three important contextual elements—culture, climate, and resources—were examined prior to the implementation of this QI project. Effective assessment of these elements aided in identification of barriers and facilitators of the implementation process. Culture refers to the values and beliefs of the people in an organization, and it has a pervasive influence on implementing change (Azzolini et al., 2018). The organization in question prioritized providing evidence-based care to improve positive patient outcomes. However, the anesthesia department in the organization did not hold frequent continuing education sessions on evidence-based practices to enhance patient safety. An educational session was held for the anesthesia providers, which focused on CA as a patient safety concern and encouraged eye protection techniques in patients receiving GA to improve patient outcomes.

Implementation climate refers to the staff's perception of the significance of innovation in the organization and their receptiveness to change. A good implementation climate fosters implementation success but creating a feedback loop on the effectiveness of the implementation will promote a more favorable climate (Helfrich et al., 2007). Management at the target site was in support of implementing this QI project, and the anesthesia staff were receptive to change. Evidence on the benefits of eye protection during induction and the emergence of GA strengthened anesthesia providers willingness to accept the change. Finally, there was no anticipated departmental cost associated with the implementation of this QI project. All educational material presented to the anesthesia provider was provided by the project lead (PL).

Intervention

Evidence from the literature review was used to guide the development of a feasible solution to combat the issue of CA at the target site. Due to a lack of standardized guidelines on CA prevention at the site, the PL created an intraoperative CA prevention guideline (Figure 3) for adult patients undergoing GA for non-eye-related surgery. This guideline included a checklist for induction and emergence from GA and served as a guide for anesthesia providers to prevent CA.

The project goals were achieved using some strategies identified in Bingham & Main (2010). The intraoperative CA prevention guideline was submitted to the Chief Anesthesiologist, project sponsor, and clinical site representative (CSR) for approval prior to project implementation. This project was implemented within a span of 15 weeks. An educational PowerPoint was presented to the anesthesia providers to deliver up-to-date evidence on the benefits of the initiative and inform them of the project timeline, data collection process, and data analysis tools. Structural changes to workflow were also explained (Figures 4 and 5 depict previous and desired processes). Additionally, the PL provided coffee and snacks as an incentive for attending the education session.

A low staff turnout for the staff education session necessitated a reexamination of the implementation process by the PL and other methods of education. A pamphlet was created and posted in all anesthesia-related work areas. The pamphlet included a QR code for the PowerPoint presentation and staff education survey generated by a secure web-based application. Also, a mass email was sent to all anesthesia providers, which included the education PowerPoint with voiceover and the education survey QR code. Educational information in written and PowerPoint formats was presented and sent out multiple times to all anesthesia providers at the facility to ensure all participants were included.

Furthermore, before the QI project start date, the intraoperative CA prevention guideline and a laminated visual prompt (Figure 6) stating “Remember to protect the patient’s eyes” were also placed on the anesthesia machine in each operating room (OR) at the target facility. The visual prompt served as an added visual reminder for the anesthesia providers to protect the patient’s eyes. Providers were also requested to fill out a three-question CA prevention compliance survey daily. The QR code for the compliance survey was attached to the posted guidelines.

Measures

Numerous clinical, functional, structural, and process measures motivated the development and implementation of this QI project. The structural measures were the use of visual prompts and the creation of an intraoperative CA prevention guideline. These measures are typically attained by ‘yes or no” answers. Hence, no validated tool was required. One process measure was provider education, with the numerator being the number of anesthesia providers who completed the staff education survey and the denominator being the total number of anesthesia providers. Another measure, providers' adherence to the guideline was measured by dividing the number of anesthesia providers who completed the compliance survey by the number of anesthesia providers who provided GA. A weekly report on the total number of providers who had general anesthesia cases per week was provided by the CSR.

This QI project had two data collection tools: a staff education survey and a CA guideline survey (Appendix C and Appendix D). Data from both surveys were generated and collected using Research Electronic Data Capture (REDCap), a secure web-based application for collecting and managing data (Patridge & Bardyn, 2018). The surveys were available as a QR code, which could be scanned with any electronic device, provided the device had a camera and internet access. The completion of the staff education survey signified the anesthesia provider had been educated and evaluated on CA prevention knowledge. The CA guideline survey measured anesthesia providers' adherence to the use of the intraoperative CA prevention guideline. It was completed daily by each anesthesia provider when general anesthesia was performed. To ensure completion and accuracy, the surveys were brief, and the QR codes for both surveys were posted in each OR and frequently used anesthesia areas.

Ethical Consideration

Provider personal information was excluded during data collection to maintain privacy. Surveys were completed anonymously by each provider, in their own space, using their personal mobile device. No patient information was collected in this QI project. Confidentiality is protected by eliminating any potential risks of data exposure during data collection. The surveys were generated, and data was collected in REDCap. REDCap, a secure password-protected, 2-factor authenticated, Health Insurance Portability and Accountability Act of 1996 (HIPAA)-compliant server was the only program used for data storage (Harris et al., 2009; Harris et al.,2019). Data collected on REDCap was only accessible by the PL and the project faculty. The Human Research Protections Office (HRPO) of the UMSOM Institutional Review Board (IRB) reviewed the QI project prior to implementation and deemed the project non-human subject research (NHSR). The project was also reviewed and approved by the site IRB before project implementation. There were no conflicts of interest during the implementation of this project.

Results

The first process goal of this project was the education of 100% of anesthesia providers, as evidenced by the completion of the staff education survey. Before implementation, in-person and virtual education were performed for all providers. Eight anesthesia providers attended the in-person staff education out of a total of twenty-five full-time providers, of which only two providers (8%) completed the staff education survey (Figure 7). The educational documents were also available to all providers via email. However, the completion rate of the staff education survey remained at 8%.

The second process goal of this project was 100% adherence to the intraoperative CA prevention guideline. This goal was achieved once throughout this project, at week 1 of project implementation. Over the course of 15 weeks, it was estimated 241 general anesthesia cases were performed, but 100 compliance surveys were completed. The compliance rate with the guideline varied and ranged from 0% to 100%. A compliance rate of 0% was noted in weeks 5 and 15. Although a notable increase in compliance was seen one week after providers were reminded in weeks 3, 5, and 12, this increase in compliance was only temporary, as the compliance rate decreased in the next two consecutive weeks. The run chart in Figure 8 illustrates the provider's compliance with the CA guidelines and interventions performed during weeks of low compliance. The median compliance rate for the CA prevention guideline use was 33 from weeks 1–10 and dropped to 25 from weeks 11–15. No shift, trends, or astronomical datapoints existed in the guideline compliance data, but four runs were present. The Institute for Healthcare Improvement (2019) explained four runs represent too few runs for 15 data points. This is a non-random variation, which could have resulted from the intermittent staff reminders to complete the compliance survey.

Discussion

This project introduced a structured process for providers to implement measures to prevent CA in patients undergoing GA. This project did not require additional staff or equipment and did not incur any financial burden on the institution. The educational materials, visual reminders, and laminated guidelines were provided by the PL. The visual reminders and laminated guidelines posted in the operating room will remain in place to promote sustainability. Interventions such as staff education, visual, and electronic reminders positively impacted compliance and will continue to be utilized to promote sustainability.

This project's results cannot be compared with findings from the literature. According to Vetter et al. (2012), implementation of a CA prevention protocol and continuing education for anesthesia providers resulted in a decrease in CA, an increase in provider documentation of eye protection, and compliance with the CA prevention protocol from 3.4% to 74.9% at six-month of initiating the prevention program. The difference in anticipated and observed outcomes could have resulted from the short time used to implement this project. Also, some limitations experienced during project implementation could have affected the project outcome. The first limitation experienced in this project was the education of new staff after project implementation had begun. Ongoing staff turnover could potentially serve as a barrier to staff education, as the project did not consider newly hired or per diem staff. After implementation has started, project champions are utilized to educate new and per diem staff, and educational materials are sent via email. This had no impact on the completion of the staff education survey.

Another limitation was anesthesia provider’s practice change was not reflected in the collected data. An independent observation of the provider's workflow during implementation showed changes in practice consistent with the guidelines. The provider's practice change did not translate into the data collected on REDCAP since the providers failed to complete the daily compliance survey. Though the QR code for the compliance survey was readily available in the operating room, provider forgetfulness was recognized as the main reason for the low number of surveys completed. Perhaps the utilization of a measuring tool that does not rely on providers to complete daily surveys could have yielded better compliance results. Furthermore, a limitation to the internal validity of the project could be a flaw in the project design or a lack of precision in the measurement of guideline compliance. To determine the rate of provider compliance with guideline, the CSR provided weekly reports of the estimated number of providers who performed general anesthesia cases. The validity of the report provided by the CSR cannot be confirmed due to limited access to chart reviews.

Conclusion

This QI project demonstrated the utilization of evidence-based guidelines to prevent CA is a low-cost way of encouraging practice change. Although the occurrence of CA in patients receiving GA rarely results in a chronic condition, CA is still a concern since it is highly preventable and causes discomfort and dissatisfaction in patients. Despite the low compliance rate with the guidelines, a change was noted in the provider's workflow. This change was in accordance with the guideline recommendations. Therefore, the guideline could serve as a cognitive aid for providers to prevent corneal abrasion in patients receiving GA.

The guidelines and visual reminders will remain posted in the ORs to ensure project sustainability. Support from the leadership of the organization will also promote sustainability. Additionally, project champions have agreed to educate new staff and future nurse anesthesia students rotating through the site on the importance of CA prevention and the benefits of utilizing the CA prevention guideline. The low cost of the intervention and little or no interruption to the provider's workflow are some strengths of this project. Future QI projects should incorporate chart audits to get an accurate number of general anesthesia cases performed daily and ensure the accuracy of the data collected. The development of a measuring tool that is easy to complete will also benefit future QI projects. The next step is to extend the guideline to include patients recovering from general anesthesia in the post-anesthesia care unit.

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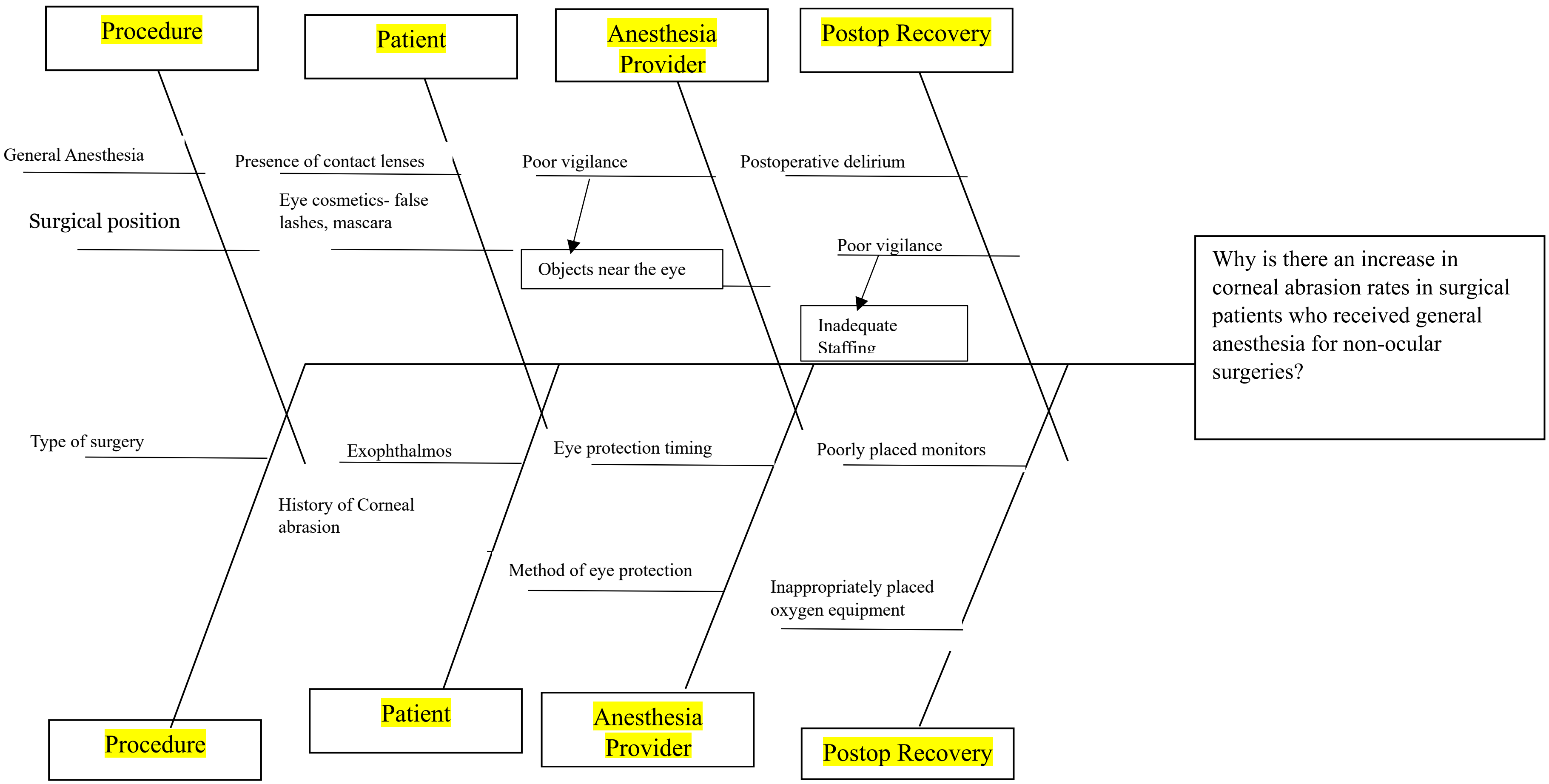
Figure 1

Fishbone Diagram



Note. Root cause analysis of Perioperative corneal abrasion

Figure 2

Framework of complex innovation implementation

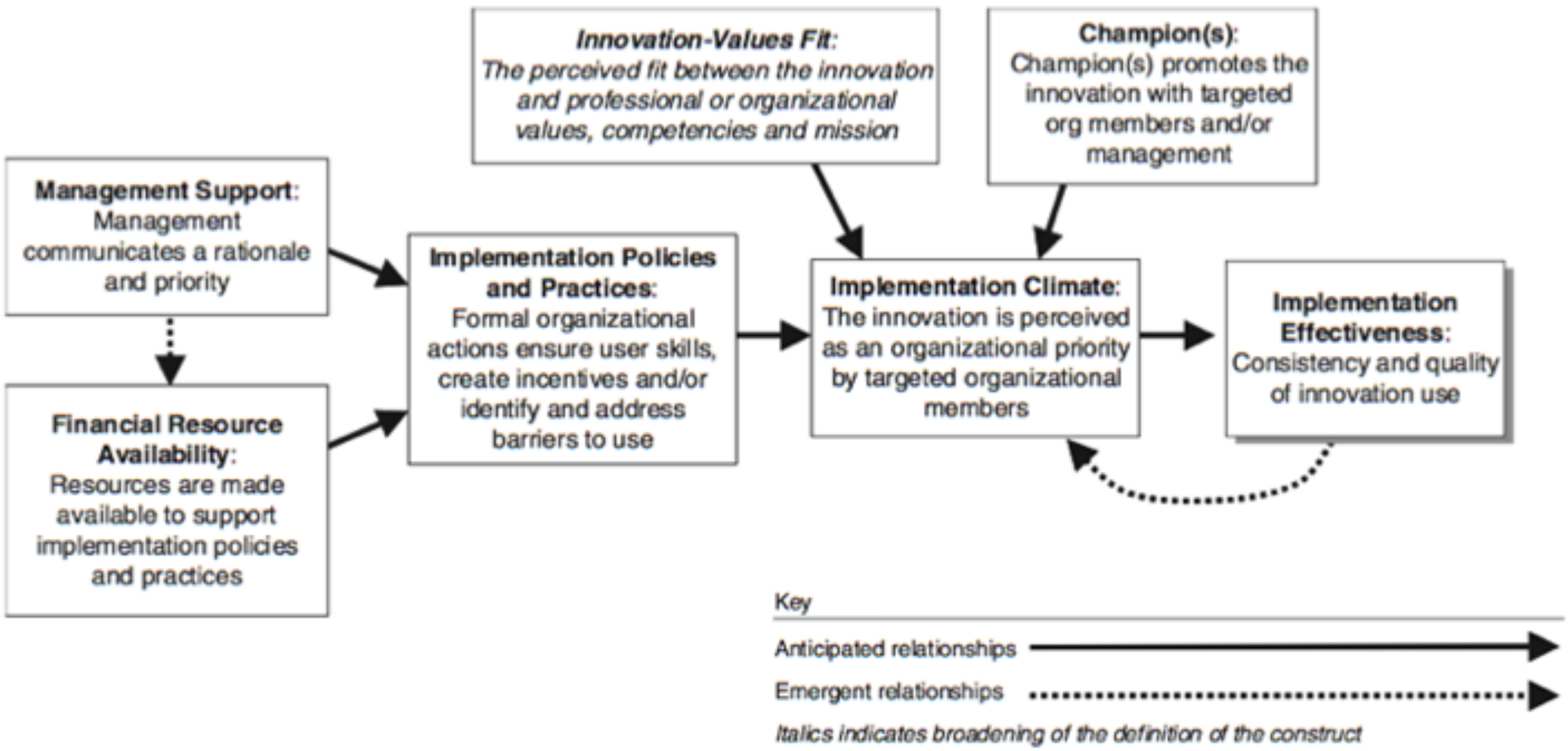


Figure 3

Intraoperative Corneal Abrasion Prevention Guideline checklist

Intraoperative Corneal Abrasion Prevention Guideline for Adult Surgical Patients Receiving General Anesthesia

INDUCTION

- Place pulse oximeter on the forth finger of the patient's nondominant hand
- Remove objects in close proximity to patient's eyes prior induction.
- Use tape or other eye protective materials to close eyelids immediately after induction of general anesthesia.

EMERGENCE

- Remove eye protection prior to emergence
- Eye protection is removed from the top toward the lower eyelid

Figure 4

Previous Process Map

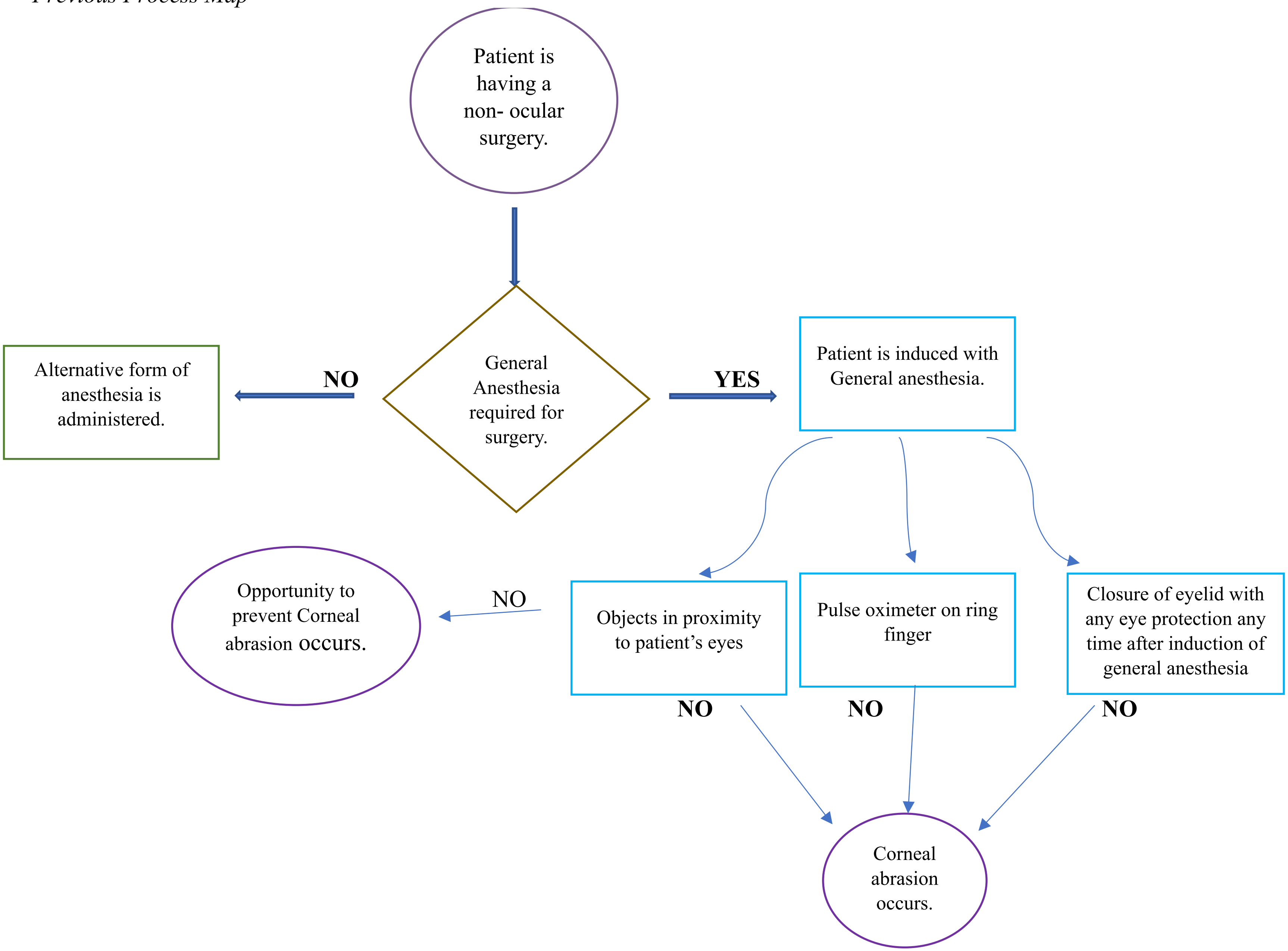


Figure 5

Desired Process Map

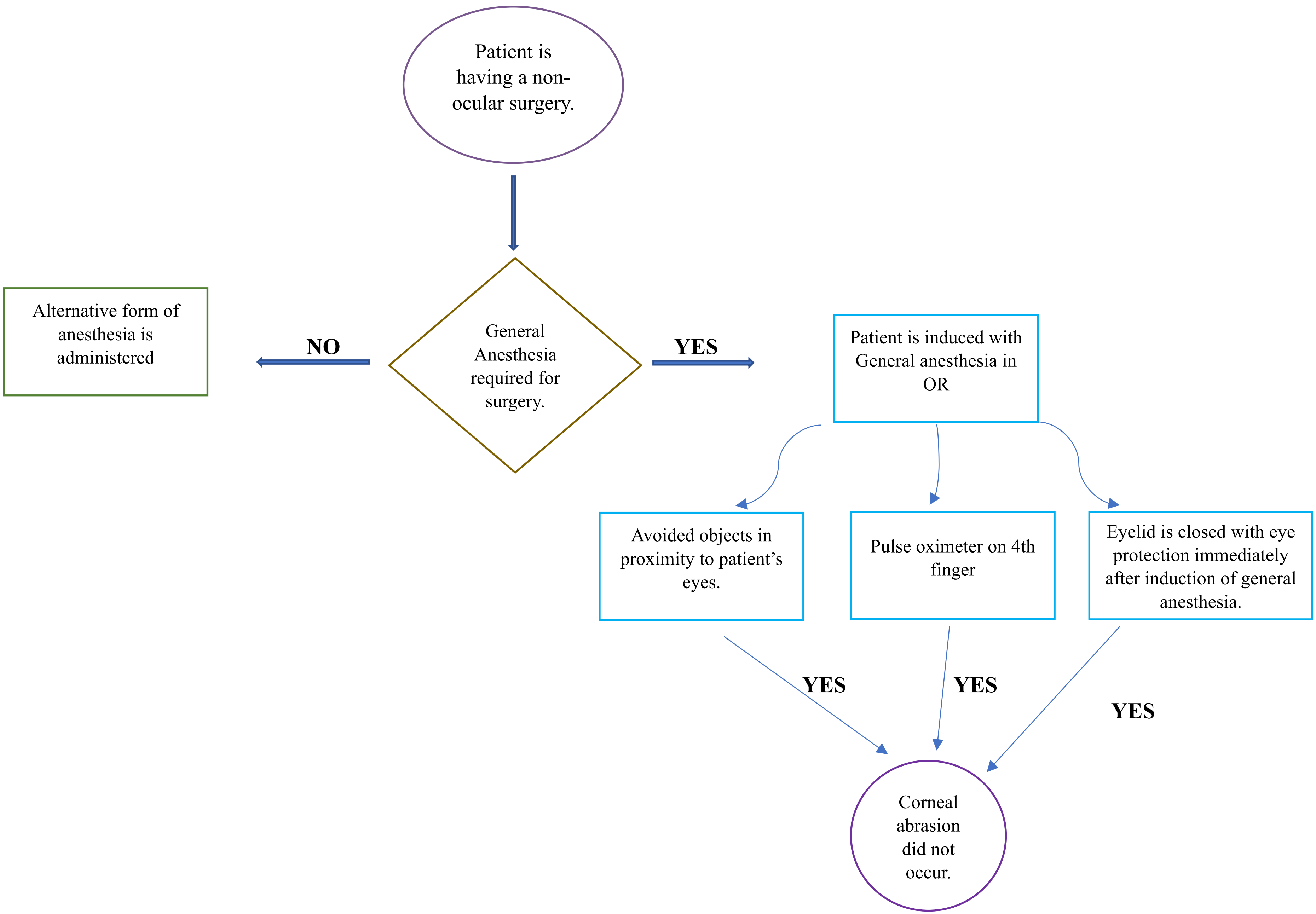


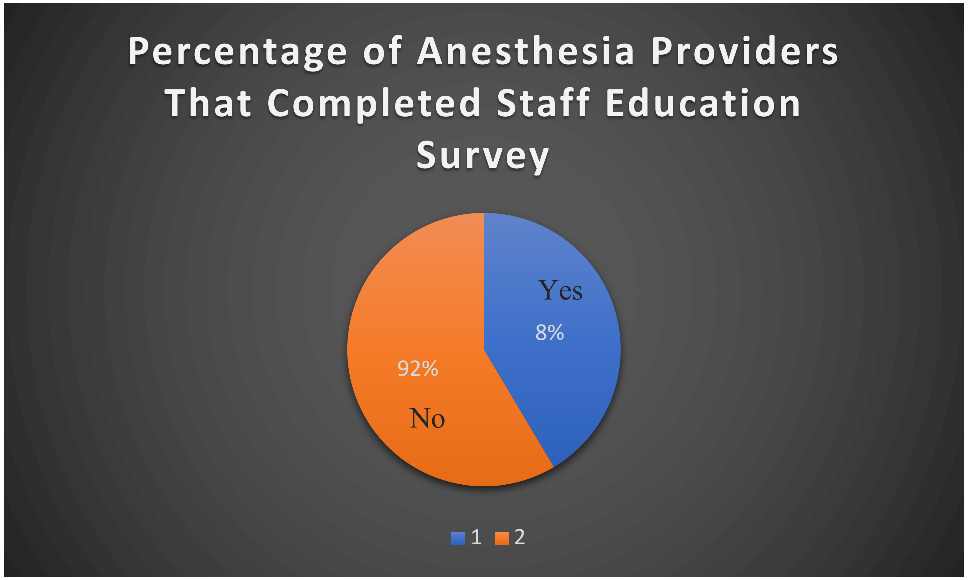
Figure 6

Visual prompt

REMEMBER TO PROTECT PATIENT’S EYES

Figure 7

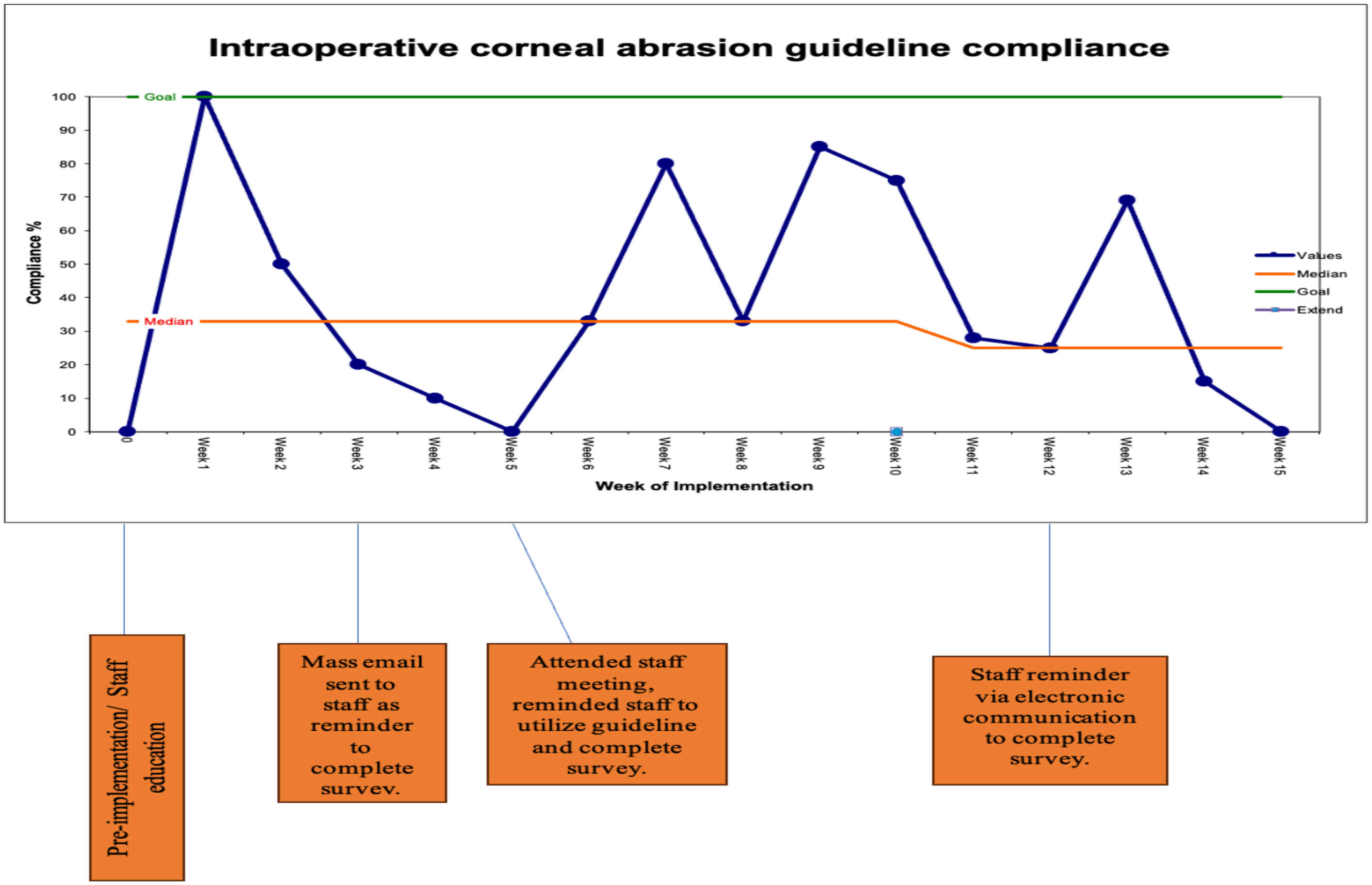
Pie Chart of Staff Education Attendance



Note: Pie chart depicting the percentage of anesthesia providers who completed staff education survey.

Figure 8

Run Chart of CA Guideline Compliance



Appendix A

Evidence Appraisal

Citation: Yang, S. C., Lee, H. Y., Chen, C. L., Huang, C. J., Wang, C. H., Cheng, K. W., Wu, S. C., Shih, T. H., Huang, C. E., Lee, Y. E., Jawan, B., Juang, S. E., & Lu, H. F. (2018). Eye Protection in Liver Transplantation Patients Under General Anesthesia. *Transplantation proceedings*, *50*(9), 2651–2653. https://doi.org/10.1016/j.transproceed.2018.02.202	
Purpose or Hypothesis	The purpose of this study was to compare the use of Opsite in eye protection with or without wet gauze following application of eye ointment in patients undergoing living donor liver transplantation (LDLT).
Design	prospective, double-blinded, randomized controlled trial
Sample	**Sampling Technique:** Convenience **Eligible Participants:** patients undergoing living donor liver transplantation (LDLT) **Excluded:** history of a previous eye disease or epithelial defects identified by preoperative fluorescein examination **Accepted:** 41 patients (82 eyes) **Control:** One eye was selected from each of the 41 patients (41/82) **Intervention:** The other eye was selected from each of the 41 patients (41/82) **Power analysis/Achieved:** Unable to determine if power analysis was met. **Group Homogeneity**: homogeneity was undetermined. Information from Table 1 revealed that both groups had comparable demographics and clinical characteristics, but no p-value was available to assess statistical significance.
Intervention	**Control Protocol:** one of the patient's eyes was protected with gauze soaked in sterile normal saline and covered with Tegaderm dressings (normal saline group) **Intervention Protocol:** The other eye was protected with the addition of Duratears ointment. It is then covered with wet gauze and finally sealed with Tegaderm dressings (Ointment group).

	Treatment Fidelity: The study provided no information on how treatment fidelity was maintained. However, the doctor who examined each patient's eyes before and at the end of the surgery, was unaware of the eye protection method used
Outcomes	**Dependent Variable:** corneal epithelial defects **DV Measure:** Fluorescein staining was used to evaluate the corneas of each patient 1 day before and at the end of the operation by the same doctor.
Results	**Statistical Results: A** T-test was use but statistical results were not stated in the study. **Conclusions**: The researchers concluded that no corneal epithelial injury was detected in either the normal saline group or the ointment group.
Level/Rational	Level 1C according to the JHNEBP hierarchy. Rationale: Randomized control trial w/2 parallel groups. Conclusions cannot be drawn due to lack of consistent evidence.

Citation: Wan, T., Wang, Y., & Jin, X. M. (2014). Corneal injury and its protection using hydro-gel patch during general anesthesia. *International journal of ophthalmology*, *7*(6), 964–967. https://doi.org/10.3980/j.issn.2222-3959.2014.06.09	
Purpose or Hypothesis	The purpose of this study was to evaluate the effectiveness of hydrogel eye patch in prevention of corneal abrasion in patient undergoing general anesthesia.
Design	double-blinded, randomized controlled trial
Sample	**Sampling Technique:** Convenience **Eligible Participants:** patients aged 18- 70 years old with American Society of Anesthesiologists (ASA) physical status 1-3 scheduled for non-ocular surgeries under general anesthesia with endotracheal tube intubation. **Excluded:** presence of corneal fluorescein staining before surgery, severe systemic disease, allergy to fluorescein or oxybuprocaine, and inability to communicate with the investigators **Accepted:** 76 patients (152 eyes) **Control:** One eye was selected from each of the 76 patients (76/152 eyes) **Intervention:** The other eye was selected from each of the 41 patients (76/152 eyes) **Power analysis/Achieved:** Unable to determine if power analysis was met. **Group Homogeneity**: homogeneity was undetermined d/t no report on demographic data

Intervention	**Control Protocol:** One of the patient's eyes was randomly selected and protected with adhesive tape. **Intervention Protocol:** The other eye was randomly selected protected with hydrogel eye patch. **Treatment Fidelity:** Both groups were treated equally. Informed consents, anesthesia protocol, and standard monitoring were similar in both groups. Computer generated software was used to allocate the intervention and control subjects. Intravenous anesthetic agents were the same: etomidate, midazolam, esmeron, remifentanil, and propofol. Providers were instructed on the proper placement of the patch. Finally, the two ophthalmologist who examined each patient were unaware of the eye protection method used.
Outcomes	**Dependent Variable:** Corneal staining and ocular discomfort **DV Measure:** Fluorescein staining under hand-held slit lamp biomicroscope was used to evaluate the corneas prior to induction of general anesthesia, after surgery, and at day 1 post-op. The staining is scored by dividing the cornea into 3 parts: 0 (none), 1 (less than half), 2 (more than half), 3 (whole). Ocular discomfort was examined using a questionnaire filled by all patients which includes eye pain, foreign body sensation, photophobia, tearing and dry eyes.
Results	**Statistical Results:** A paired T-test was used to analyze the data. Results from Corneal fluorescein staining scoring revealed that 12 eyes (15.8%) from the hydro-gel patch group and 30 eyes (39.5%) in the adhesive tape group showed ocular injury immediately after surgery. Comparison of the two groups revealed that less ocular injury occurred in the hydro-gel patch group than the adhesive tape group ($P<0.01$). Eye discomfort analysis revealed 4 eyes in hydro-gel patch group and 6 eyes in adhesive tape group reported eye discomfort with scores of 1 or 2. No statistical difference was found between the two groups ($P>0.05$). **Conclusions**: The researchers concluded that utilization of hydro-gel patch decreased corneal injury in patients who received general anesthesia compared to those that adhesive tape.
Level/Rational	Level 1B. Rationale: Randomized control trial w/2 parallel groups. The literature had a reasonably consistent result, but sufficiency of sample size was undermined since power analysis was not stated.

Citation: Drzymalski, D. M., Ward, K., Hernandez, J. M., Hoot, J., Au, S. C., Yang, F. C., & Azocar, R. J. (2021). Correction to: The effect of Tegaderm™ versus EyeGard® on eyelid erythema during general anesthesia: a randomized-controlled trial. *Canadian journal of anaesthesia = Journal canadien d'anesthesie*, *68*(7), 1102. https://doi.org/10.1007/s12630-020-01612-9	
Purpose or Hypothesis	The goal of the study was to assess the effectiveness of utilizing Tegaderm to cover the eyelids during general anesthesia to decrease eye redness compared to the use of Eye guard
Design	Prospective, randomized, double-blinded study

Sample	**Sampling Technique:** Convenience **Eligible Participants:** Patients 18 years and older undergoing general anesthesia. **Excluded:** Presence of pre-existing eye trauma, piercing or injury, surgical prone positioning, head/ neck surgery, sensitivity/ allergy to tape. **Accepted:** 151 participants Both Tegaderm and Eye Gard were applied to the eyelids **Intervention group 1:** split face study, one eye was selected from each of the 151 participants. **Intervention group 2:** the second eye was selected from each of the 151 participants. **Power analysis/Achieved:** Met- a power of 80% was needed which totaled 227 eyelids. The study had 302 eyelids. **Group Homogeneity**: Homogeneity was presumed to be met. Split face study, both interventions performed on the same group of participants with similar demographic. No p value available
Intervention	**Intervention Protocol:** Application of Tegaderm on one eyelid. **Intervention Protocol:** Application of Eye Gard on the other eyelid **Treatment Fidelity:** Individuals who evaluated the data were unaware of the participant's allotment. Each group was treated equally
Outcomes	**Dependent Variable:** Although postoperative eyelid erythema was the DV, the study also assessed corneal abrasion and patient satisfaction as the secondary variable. **DV Measure:** Photographs of each participant were taken prior to induction of general anesthesia and before tape application. These photographs were analyzed by 3 anesthesiologists and compared to the postop photographs for new abnormalities. Eyelid erythema was evaluated on a scale of 0–3 (0 - no erythema, 1- mild, 2-moderate erythema, and 3 indicating severe erythema). Corneal abrasion was measured by evaluating patient's complaints of foreign body sensation in the eye. Reliability of measurement tool was not tracked in the study.
Results	**Statistical Results:** 117 (77%) eyelids covered with Tegaderm, and 105 (70%) eyelids covered with Eye Gard had erythema $P = 0.03$. Corneal abrasion was not reported in either group. **Conclusions**: Covering the eyelid with Eye Gard may offer better protection against eye erythema over the use of Tegaderm. But both adhesive tape eye protections offer equal protection of the eyes against corneal abrasion.
Level/Rational	Level 1B- Randomized control trial- The literature had a reasonably consistent result; sufficient sample size, and moderately definitive conclusions.

Citation: Grixti, A., Sadri, M., & Watts, M. T. (2013). Corneal protection during general anesthesia for nonocular surgery. *The ocular surface*, *11*(2), 109–118. https://doi.org/10.1016/j.jtos.2012.10.003	
Purpose or Hypothesis	The goal of this study was to analyze the causes of perioperative corneal abrasion (CA) and compare different eye protection techniques to find the most effective means to prevent CA during general anesthesia.
Design	Systematic review of RCT's and historical controlled study.
Sample	**Sampling Technique:** systematic search of database was performed using the keywords *general anesthesia; eye; cornea; abrasion*. The search engines of CINAHL, MEDLINE and EMBASE were all used in the initial search. **Eligible Participants:** Studies with higher level that analyze the causes of perioperative corneal abrasion (CA) and compare different eye protection techniques. **Excluded:** case reports or studies on unusual eye complications after general anesthesia. **Accepted:** 52 articles **Power analysis/Achieved:** unable to determine, 9 studies (8 RCT's and historical controlled study) was selected with varied sample sizes. **Group Homogeneity**: homogeneity was undetermined
Intervention	All studies reviewed compared different eye protection techniques to find the most effective means to prevent CA during general anesthesia
Outcomes	**Dependent Variable:** Incidence of corneal abrasions. Definition of corneal abrasion was based on what was used in each clinical study
Results	**Statistical Results:** Passive eye closure was discouraged across most of the studies**. F**ive RCT's identified eye taping alone as a greater preventative method for corneal abrasion but resulted in side effects in two RCT's. Horizontal eyelid taping is preferred for complete closure of the eyes. In four RCTs, Methylcellulose created fewer side effects than paraffin-based ointments during general anesthesia. Eye ointment is recommended in patients with facial burns. Low incidence of CA was noted from the use of bio-occlusive dressings (Tegaderm) in a historical controlled study. **Conclusions**: Inconclusive data exist on the most effective eye protection to prevent corneal abrasion. However, eyelid taping remains the most successful method. The other means of eye protection can be used to provide additional protection

Level/Rational	**IIB-** large number of articles reviewed consisting of RCT's and controlled studies with large sample sizes. Reasonably consistent recommendations based on fairly comprehensive literature review that includes some reference to scientific evidence

Citation: 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, 927-932. https://dx.doi.org/10.1097/ICO.0000000000001972	
Purpose or Hypothesis	The purpose of this study was to perform a systematic review of international literature assessing the risk factors, preventive steps, and treatments for perioperative corneal injuries for non-ocular surgery.
Design	A systematic review and meta-analysis
Sample	**Sampling Technique:** A database search was initiated using PubMed, Embase, and the EBM Reviews **Inclusion criteria:** articles that only studied perioperative corneal injuries after non-eyes related surgeries. **Excluded:** case reports and small case series with fewer than 5 patients. **Accepted:** 16 articles were evaluated (1 RCT, 2 prospective nonrandomized studies;2 retrospective studies, 1 meta-analysis, 2 hospital-based observational studies, 1 educational intervention trial, and 9 retrospective case series) **Power analysis:** unable to determine due to varied sample sizes. 9 patients represent the smallest sample size and 113,162 patients, the largest sample size.
Intervention	The reviewed studies were classified into two - epidemiological reports and trials of different interventions. Epidemiological studies analyzed the rates of perioperative corneal injuries after nonocular surgery, and the trials studied ways of preventing and treating corneal abrasion.
Outcomes	**Dependent Variable:** Corneal abrasion **DV Measure:** Inconsistent measurement tool. Variable forms of reported rates of corneal abrasion
Results	**Statistical Results:** Taping of the eyelid with or without ointment and the use of Tegaderm/bio-occlusive dressing demonstrated superiority in prevention of corneal abrasion. **Conclusions**: Eyelid taping and Tegaderm could serve as a clinical option for the prevention of corneal abrasion following general anesthesia

Level/Rational	Level IIC- lacked consistency in reported sample sizes, patient demographic, and incidence of corneal abrasion

Citation: Porter, S. B., Chamorro-Pareja, N., Boles, K. S., Rodgers, I. L., & Rodrigues, E. S. (2022). A quality improvement project to decrease perioperative and periprocedural corneal abrasions. *Journal of perianesthesia nursing: official journal of the American Society of PeriAnesthesia Nurses*, *37*(3), 317–320. https://doi.org/10.1016/j.jopan.2021.06.101	
Purpose or Hypothesis	The purpose of this study was to evaluate the institution's rate of perioperative and periprocedural corneal abrasions (CAs) and implemented a quality improvement project to improve our detection of CAs and decrease their incidence by at least 25% over 12 months."
Design	Retrospective review before and after initiation of a quality improvement project at a single tertiary care institution
Sample	**Sampling Technique:** Convenience **Eligible:** procedural patient receiving any type of anesthesia. **Excluded:** None **Accepted:** 43,585 **Control:** 19760 **Intervention:** 23825 **Power analysis/Achieved:** N/A **Group Homogeneity**: homogeneity was undetermined.
Intervention	**Control Protocol:** general anesthesia cases from (2014-2018) **Intervention Protocol:** After the implementation of the CQI protocol (2016-2018) **Treatment Fidelity:** online learning module consisting of a slide presentation and test to create awareness of CAs and increase provider's "buy-in".
Outcomes	**Dependent Variable:** Reduce the occurrence of intraoperative corneal injuries. **DV Measure:** cases were identified by documentation of a CA by any personnel of the peri anesthesia unit, the prescription of proparacaine eye drops within 24 hours after anesthesia, or consultation with an ophthalmologist within 24 hours after anesthesia.

Results	**Statistical Results:** baseline incidence from 2014-2015 was approximately 0.22%, or 1 in 460. After the change in practice, from 2016-2017, 21 CAs were reported, resulting in an incidence of 0.09%, or approximately 1 in 1126. Over additional follow-up from 2017-2018, 23 CAs were reported, resulting in an incidence was 0.097%, or approximately 1 in 1036. Compared with 2014-2015, the absolute incidence rate of CA decreased significantly by 13% (95% CI, 0.20-0.05; P < .001) **Conclusions**: Implementation of a CA prevention protocol which includes method of eye protection could reduce the incidence of corneal abrasion in patients receiving general anesthesia.
Level/Rational	IVB-Study was conducted by credible clinicians from academic hospital. Statistical analysis was appropriate, and results were consistent with other studies. Recommendations were clear and supports the result. Strengths and limitations of included studies were not clearly defined. Recommendations were clear and supported by statistically significant results.

Citation: 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.proxy-hs.researchport.umd.edu/10.1016/s1553-7250(12)38065-3	
Purpose or Hypothesis	The purpose of this study was to evaluate the causes of perioperative corneal abrasions, assess eye protection strategies, and identify the best technique to prevent corneal abrasions following general anesthesia”
Design	Case-Control study with a Continuous Quality Improvement (CQI) Project implemented by the Anesthesiology faculty at University of Alabama, Birmingham from (12/01/2005- 09/30/2007) and postimplementation (10/01/2007- 06/30/2011). Nonrandomized, two group time-series using the Seven-Step Problem-Solving Model
Sample	**Sampling Technique:** Convenience **Eligible:** All cases where general anesthesia was given. **Excluded:** None **Accepted:** 163,195 **Control:** 50,151 **Intervention:** 113,044 **Power analysis/Achieved:** N/A **Group Homogeneity**: homogeneity was undetermined. no p-value was available.

Intervention	**Control Protocol:** general anesthesia cases from 12/01/2005-09/30- 2007 prior to implementation of CQI **Intervention Protocol:** After the implementation of the CQI protocol- standardized eye protection protocol **Treatment Fidelity:** The electronic medical record was utilized to document the implementation of the new protocol. The providers were education on the importance of documentation by the CQI committee. Practitioners were randomly observed on the method of eye protection.
Outcomes	**Dependent Variable:** Reduce the occurrence of intraoperative corneal injuries and promote documentation of strategies used to prevent corneal abrasion. **DV Measure:** EMR was used to obtain data on the cases of corneal abrasion. Current departmental quality assurance practices were used to evaluate corneal abrasion. Reliability of this tool cannot be verified.
Results	**Statistical Results:** Crude exposure odds ratio with a 95% CI was utilized for pre and post implementation. U-control chart to count the number of corneal abrasion injuries per month. Time-series chart tracking electronic medical records with eye protection documented. Chi-square test to determine significance of the prevention methods using $P<0.05$. 58 cases of corneal abrasion were identified in the control group and only 10 in the intervention group. The incidence of corneal injury was 1.20/1,000 general anesthetics before versus 0.09/1,000 general anesthetics after implementing our prevention program ($p < .001$). **Conclusions**: Implementation of a CA prevention protocol which includes method of eye protection could reduce the incidence of corneal abrasion in patients receiving general anesthesia.
Level/Rational	IVA- large sample sized, no randomization but the protocol and intervention were detailed. Study was conducted by credible clinicians from academic hospital. Statistical analysis was appropriate, and results were consistent with other studies. Recommendations were clear and supports the result

Appendix B

Evidence Synthesis

JHNEBP Model Level	Total Number of Sources	Author and Quality Rating of each study	Synthesis of Findings
Level 1 Experimental study · Randomized Controlled Trial (RCT) · Systematic review of RCTs with or without meta-analysis	3	Yang et al. = 1C Wan et al. = 1B Drzymalski et al. = 1B	Yang et al., (2018) confirms that opsite offers protection against CA with or without additional use of eye ointment. This data is inconsistent with Drzymalski, et al., (2021) findings of comparable benefits with the use of Tegaderm or Eye Gard. It also conflicts with Wan et al., (2014) studies which recognizes hydrogel as a superior form of eye protection compared to tape. Although variation exist in each study on the most effective method of eye protection. All three studies confirm use of eye protection decreases CA in patients receiving GA.
Level II Quasi-experimental studies · Systematic review of a combination of RCTs and quasi-experimental studies, or quasi-experimental studies only, with or without meta-analysis **Level III** Non-experimental study · Systematic review of a combination of RCTs, quasi-experimental, and non-experimental studies, or non-experimental studies only, with or without meta-analysis · Qualitative study or systematic review of qualitative studies with or without meta-synthesis	2	Grixti et al. = IIB Papp et al. = IIIC	Both Grixti et al., (2013) and Papp et al., (2019) confirms that the using tape to close the eyelid is an effective method of protecting the patient eyes during GA. However, Papp et al., (2019) further described the use of Tegaderm/bio-occlusive dressing as the most beneficial method of eye protection.
Level IV Opinion of respected authorities and/or reports of nationally recognized expert committees/consensus panels based on scientific evidence	1	Vetter et al. = IVA Porter et al.= IVB	Vetter et al. (2012) and Porter et al., (2022) explained that implementation of a CA prevention protocol which includes method of eye protection could reduce the incidence of corneal abrasion in patients receiving general anesthesia.
Overall Quality Rating w/rational and Recommendation: The studies appraised consisted of 3 RCTs (level 1B and C), 2 systematic reviews of RCTs and non-experimental studies (IIB and IIC), and 2 expert reports (IVA & B). Despite the varying levels of evidence of the appraised studies, there is good and consistent evidence to support a practice change.			

Appendix C

Staff education survey

Staff Education Survey

Page 1

Please complete the survey below.

Thank you!

1)	Corneal abrasion prevention session attended	◯ Yes ◯ No
2)	Date of Educational Session	________________________
3)	Did you find this educational session informative?	◯ Yes ◯ No
4)	How knowledgeable were you, regarding corneal abrasion prevention practices before this session?	◯ Not at all ◯ Somewhat knowledgeable ◯ Very Knowledgeablble
5)	How motivated are you to use the intraoperative corneal abrasion prevention guideline to prevent corneal abrasion?	◯ Not at all ◯ Somewhat motivated ◯ Very motivated

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Appendix D

Corneal Abrasion Intraoperative Guideline Survey

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CA abrasion guideline survey

Please complete the survey below.

Thank you!

1) How many General anesthesia cases did you perform today? ______________________

2) When was eye protection used during laryngoscopy
   - ☐ Before
   - ☐ After

3) Did you follow the intraoperative corneal abrasion preventative recommendations as suggested in the guideline
   - ☐ Yes
   - ☐ No