Perioperative Corneal Abrasion Prevention Protocol in Prone and Lateral Positioned Patients

Alison R. Cortez

Under Supervision of

Richard Conley

Second Reader

Erica Alessandrini

A DNP Project Manuscript
Submitted in Partial Fulfillment of the Requirements for the
Doctor of Nursing Practice Degree

School of Nursing, University of Maryland at Baltimore
May 2022

Abstract

Problem & Purpose: Corneal abrasions (CAs) are the most common anesthesia-related perioperative ocular injury in non-ocular surgery. Studies show the most common patient-related risk factors include advanced age, dry eyes, and an ophthalmic history. Procedure-related risk factors include general anesthesia, lateral or prone positioning, longer procedures, and robotic surgery. Properly taping eyes closed prior to airway manipulation can prevent corneal abrasions. Anesthesia providers at a medium-sized community hospital found approximately five CAs out of 500 cases occurred in adult surgical patients despite preventative efforts. This Quality Improvement (QI) project implemented a preoperative CAs risk assessment and intraoperative CA prevention protocol to improve the detection of risk factors and implement intraoperative prevention methods. **Methods:** Inclusion criteria for the preoperative risk assessment were adult patients, scheduled for elective surgery, and receiving general anesthesia. Exclusion criteria included pediatrics, parturient, non-elective surgery, and not receiving general anesthesia. The inclusion and exclusion criteria for the intraoperative prevention protocol remained the same, with the addition of those placed in lateral or prone position to be included and other positions to be excluded. Ocular occlusive dressings were stocked in all operating rooms. Implementation of yes/no checklist forms included a Preoperative CA Risk Assessment of Patient-Related Factors (five-item) and Procedure-Related Factors (four-item), and an Intraoperative CA Prevention Protocol (15-item). Education was provided to preoperative nurses and anesthesia providers. Completed forms were deposited into a locked box in the anesthesia lounge. Baseline data collection began at the start of the implementation period, and weekly thereafter. Data was recorded without identifiers using a secure data management Excel spreadsheet based on inclusion and exclusion criteria. Outcome measures included use of the preoperative risk assessment and the

intraoperative prevention protocol with compliance rates displayed using run charts. **Results and Conclusion:** The risk assessment had compliance rates from 5% to 61% (median=30%). The prevention protocol had compliance rates from 6% to 100% (median=89%). The occurrence of corneal abrasion decreased from 2 to zero per week. A QI project implementing a preoperative CA risk assessment and an intraoperative prevention protocol will improve the delivery of quality care and patient outcomes in the perioperative period.

Perioperative Corneal Abrasion Prevention Protocol in Prone and Lateral Positioned Patients

The incidence of corneal abrasions (CAs) during the perioperative period occurs at a rate of up to 59%, with a cumulative rate of 0.64% (Papp et al., 2019). CAs are the most common anesthesia-related perioperative ocular injury in non-ocular surgery (Papp et al., 2019). Symptoms of CAs can range from mild irritation or a foreign body sensation to severe ocular damage that can become permanent (Segal et al., 2014). Often, patients rate the pain associated with a CA higher than the surgical incision site (Segal et al., 2014). The most common patient-related risk factors for developing a CA include advanced age, dry eyes, concomitant ophthalmic diagnoses, and previous ocular surgery (Segal et al., 2014). Procedure-related risk factors include receiving general anesthesia, lateral or prone positioning, equipment, longer procedures (>1 hour), and robotic surgery (Papp et al., 2019; Segal et al., 2014). Properly taping eyes closed prior to airway manipulation can prevent CAs. A quality improvement (QI) project took place at a medium-sized community hospital with 20 operating rooms (ORs). Anesthesia providers reported approximately five CAs out of 500 cases occurred in adult surgical patients despite preventative efforts during a one-month period. A risk assessment for perioperative CAs or standardized intraoperative prevention methods were not in place. The pre-implementation process flow map is included in Appendix A, Figure A1. On average, five adult surgical patients under-going general anesthesia were positioned lateral or prone each day. A total of 15 preoperative Registered Nurses (RNs) and 30 anesthesia providers were involved in the implementation process. For the vulnerable non-English speaking patients, language interpreters were available to assist during the preoperative risk assessment interview completed by the preoperative nurses and anesthesia provider. The purpose of this QI project was to implement a

preoperative CA risk assessment and an intraoperative prevention protocol in adult surgical patients placed in the lateral or prone positions to reduce the rate of CAs.

Literature Review

A systematic review (SR) with meta-analysis by Papp et al. (2019), found the most common risk factors for CAs include longer procedures, general anesthesia, and advanced age. The most common effective prevention strategies include eyelid taping with a bio-occlusive dressing (Tegaderm). Two of the 16 articles demonstrated a statistically significant decrease in the rate of CAs with education alone. An extensive and reproducible literature search was conducted by the authors. The sample size was small, and no power analysis was provided. Heterogeneity of the sample allowed generalizability of the results. Recommendations were clear, supported with statistically significant results, and consistent with other studies. The SR was assigned a level I evidence per Melnyk & Fineout-Overholt (2019) and a B quality rating per Newhouse (2006).

A retrospective review (RR) by Segal et al. (2014) demonstrated statistically significant risk factors include advanced age, general anesthesia, large blood loss, and trendelenburg or prone positioning. This study had a sufficient sample sized by using convenience sampling, and a control group was randomized. Exclusion criteria was based on randomization, although not detailed. Generalizability is possible due to the heterogeneity of the sample. Recommendations were clear, supported with statistically significant results, and consistent with other studies. The RR was assigned a level IV evidence per Melnyk & Fineout-Overholt (2019) and a B quality rating per Newhouse (2006).

A randomized control trial (RCT) by Kocatürk et al. (2019) found all patient groups who received general anesthesia had reduced basal tear production post-operatively. Artificial tear

liquid gel containing polyacrylic acid (Viscotears) produced the most corneal epithelial defects, hyperemia, and chemosis. Hypoallergen adhesive tape (Hypafix) produced these symptoms the least. Blurry vision occurred most with an antibiotic ointment (Terramycine) and ocular lubricant pomade (Duratears). The RCT used a sufficient randomized sample size but did not have a control group. The exclusion criteria and power analysis were not detailed. The intervention protocol clearly detailed blinding of the interventionalist. Generalizability was impeded due to a homogeneous sample. The RCT was assigned a level II evidence per Melnyk & Fineout-Overholt (2019) and a B quality rating per Newhouse (2006).

A continuous quality improvement (CQI) study by Vetter et al. (2012) found intraoperative eye protection and an ongoing educational program resulted in a significant decrease in monthly CAs and healthcare costs. A large sample size was utilized. Credible clinicians from an academic hospital conducted the CQI. No randomization was used in this well-designed study. Protocols and interventions were discussed in detail. Generalizability is impeded due to a homogeneous sample. The CQI was assigned a level IV evidence per Melnyk & Fineout-Overholt (2019) and an A quality rating per Newhouse (2006).

Overall, the evidence agrees standardized ocular protection, reporting, and education initiatives decrease rates of perioperative CAs (Papp et al., 2019; Vetter et al., 2012). Use of bio-occlusive dressings are the best prevention of CAs versus using tape with an ointment, while manual closure alone resulted in CAs 59% of the time (Papp et al., 2019). Ocular lubricants prior to taping eyes are recommended for patients with dry eye syndrome but must be preservative free (methylparaben and chlorobutanol) (Kocatürk et al., 2019). Lubricants can lead to CA by causing blurry vision or a foreign body sensation and the urge to rub the eyes (Kocatürk et al., 2019). Viscotears was found to cause the most damage to the eyes and Duratears caused the most

blurry vision (Kocatürk et al., 2019). See Table 1 for a complete evidence review and Table 2 for a complete synthesis of evidence presented in the studies supporting this QI project.

Theoretical Framework

The m iddle-range theory, Theory of Unpleasant Symptoms (TOUS), was developed to understand the unpleasant symptoms experienced by patients (Lenz et al., 1997). The causative factors and their additive relationships include physiological, situational, and psychological factors. Understanding the symptoms and identifying causative factors using the TOUS can assist healthcare professionals initiate preventative measures. The TOUS was applied to unpleasant symptoms related to CAs and prevention including a preoperative risk assessment and an intraoperative prevention protocol (Figure 1). When providing education to the preoperative RNs and anesthesia providers, it was imperative to share the "why" for the proposed initiatives. Learning about CAs negative associated symptoms, risk factors, and prevention method led to collaboration and prioritization of prevention methods.

The Implementation Process framework described by Helfrich et al. (2007) uses new complex innovations and requires multiple collaborations to actively coordinate and achieve organizational benefits. The framework details six areas of implementation to achieve effectiveness in an organization: support from management, financial resource availability, innovation–values fit, presence of a champion, implementation of policies and procedures, and the implementation climate. Gaining support from the department chair resulted in a climate change and procuring ocular occlusive dressings. Collaboration with the department's office manager was necessary to achieve the structural goals. Support from innovation champions who were seasoned, highly regarded anesthesia providers, facilitated achieving the process goals. Outcome goals were met by retaining the support of management and innovation champions,

aiming to mirror the user's values, and maintaining open communication during the implementation period. See Appendix A, Figure A2, for evidence of the post-implementation process flow.

Methods

The QI project took place in a medium-sized community hospital with 20 ORs. On average, 500 elective surgical cases for adult patients were scheduled monthly. Approximately five adult surgical patients that received general anesthesia were positioned lateral or prone during their procedure each day. An average of 15 preoperative RNs and 30 anesthesia providers were involved in implementing the project initiatives. For the vulnerable non-English speaking patients, language interpreters were available to assist during the preoperative risk assessment interview completed by the preoperative RNs and anesthesia providers. Demographic data was not used in this project. Patient and provider data remained confidential, and data collection instruments used were destroyed at the end of the project. Forms were kept in a locked box in the anesthesia lounge. Data was collected and stored on an internal password-protected computer accessible only by the Doctor of Nursing Practice (DNP) QI Project Lead.

Structural changes resulted in the development of two yes/no checklists, including a preoperative risk assessment and an intraoperative prevention protocol. The preoperative CA risk assessment checklist consisted of patient-related factors (five-item) and procedure-related factors (four-item). The intraoperative CA prevention protocol contained a 15-item checklist. See Appendix B, Figure B1 and Figure B2, for the paper-based implementation tools. Inclusion criteria for the preoperative risk assessment were adult patients, scheduled for elective surgery, and receiving general anesthesia. Exclusion criteria included pediatrics, parturient, non-elective surgery, and not receiving general anesthesia. The inclusion and exclusion criteria for the

intraoperative prevention protocol remained the same, with the addition of those placed in lateral or prone position to be included and other positions to be excluded. The completion of the forms was evaluated weekly to determine compliance rates based on the eligibility criteria. Process changes took place with the approval of stakeholders including the Perioperative Nurse Manager, Director of Nursing, Chair of the Anesthesia Department, and the Office Manager of the Anesthesia Department. Additionally, verbal commitments were obtained from change champions eager to support and participate in the QI project. A formal presentation with evidence of the problem and solutions supported with a detailed evidence review was utilized to gain buy-in. Education was provided to preoperative nurses and anesthesia providers at the beginning of the implementation period. Attendance was recorded on a sign-in sheet. Ocular occlusive dressings were stocked in all ORs, for which a random observation tool was used once during the third week of implementation to confirm distribution. The completed paper-based checklists were deposited into a locked box in the anesthesia lounge. Baseline data collection began at the start of the implementation period, and weekly thereafter.

Results

The structural goals met included the development and implementation of the checklists on paper forms. Additionally, the random observation tool used during the third week of implementation confirmed distribution of ocular occlusive dressings appropriately stocked in all ORs. A structural goal initially set for the QI project included integrating the checklists into the electronic health record (EHR), but this goal was not met. The process goals were partially met, which included the use of a preoperative risk assessment and an intraoperative prevention protocol with compliance rates displayed using run charts. Over the course of 15 weeks, the median compliance rate for the preoperative risk assessment was 30%, with a range of

compliance rates from 5% to 61%. The median compliance rate for the intraoperative prevention protocol was 89%, with a range of compliance rates from 6% to 100%. A compliance rate for the intraoperative prevention protocol of 0% was noted for weeks one through four. The outcome goals were met, with the median number of perioperative corneal abrasion occurrences of zero, and a range of occurrences from zero to two. No outliers were noted in any of the data sets. The expected number of runs for 15 points are five to 12 indicating an appropriate number of runs and a random pattern of change. The data set for the risk assessment compliance rates were noted to have six runs, indicating a random pattern of change. Additionally, special cause variation was noted with a shift at week nine and a positive trend from weeks seven to 11. The data set for the prevention protocol compliance rate was noted to have no shifts and three runs, indicating random variation. Additionally, a positive trend was noted from weeks seven to 12, indicating a special cause variation. The data set for the corneal abrasion rates were noted to have five runs and no shifts, indicating a random pattern of change. Additionally, a positive trend was noted during week 11 to 15, indicating a special cause variation.

In conclusion, all structural goals were met, except for the EHR integration of the risk assessment. The process goal for the prevention protocol was met with a compliance rate of 100% during week 12 but was not sustained. The compliance rates for the risk assessment did not reach the goal of 100%, with the highest rate of 61% seen at week 11. The outcome goal, zero occurrences of perioperative CAs, was consistently met from weeks 11 to 15. An increase in compliance rates for the use of the checklists correlated with a decrease in the number of perioperative CA occurrences. See Appendix C, Figures C1, C2, and C3 for evidence of the data run charts.

Discussion

A delay in distribution of the intraoperative prevention protocol for weeks one through four is reflected in the data set, secondary to unforeseen barriers in developing and obtaining final approval of the prevention protocol. Upon collaboration with the department's office manager, this structural process was facilitated and prioritized. The shift noted after week four for the prevention protocol compliance rate represents the time-period when the protocol became available for staff use, followed by re-education. The positive trends noted in the data sets for the compliance rates correlate with a mass email sent to remind staff of the project objectives, evidence of low compliance rates, and a PowerPoint presentation for educational reference. This positive change was sustained with sequential staff meetings where staff were updated with the outcome data, indicating the positive influences of completing the project's initiatives. Additionally, the Change Champions were further consulted to improve compliance rates by reinforcing the need to complete the project's initiatives.

Results of this project correlated with the literature indicating staff education, increased awareness of the clinical problem, and a standardized method of intraoperative ocular protection leads to a decrease in perioperative CAs. Following education and increased awareness of the clinical problem, an increase in compliance rates for the use of the preoperative risk assessment and the intraoperative prevention protocol was noted. A CA occurrence of zero was not evident until after distribution and use of the intraoperative prevention protocol.

Limitations of the QI project noted were the generalizability of the outcomes, using paper-based checklist instead of integration of the checklist into the EHR, and the data collection method used for the number of perioperative CA occurrences. These limitations may affect the internal validity of the QI project outcomes. The aims and methods of this project are intended

for internal QI purposes at the project site. Results and outcomes are not generalizable to similar healthcare settings or populations. Interventions were specifically designed to address a practice gap related to a perioperative CA prevention protocol that would decrease CAs based on resources available in this specific department. Reduced accountability was noted related to the use of the paper checklists. A barrier to integration of the checklist into the EHR was met despite several stakeholders' verbal agreement to the structural change. Obtaining written agreement and approval for an EHR integration from stakeholders should be done in the early processes of similar QI projects. This will allow time for the accountable stakeholders involved to make the necessary changes. Integration of the checklists into the EHR could include an electronic warning when not completed, and an electronic signature from the user upon completion. The failure to obtain support for the proposal to integrate the checklists into the EHR resulted in a lower than expected compliance rate. Lastly, an informal collection of corneal abrasion data was utilized instead of the intended method, which relied on data from the EHR. The electronic method of reporting perioperative CAs and collecting the number of occurrences was halted by more pressing organizational changes made in the EHR. Instead, collaboration with the department chair and the QI project's Clinical Site Representative (CSR) was used to collect the data. A mass email sent to staff requested an informal method of reporting the number and date of a CA occurrence for cases the staff member was involved in or treated over a 15-week period. Informal data collection methods and manual extraction of data and analysis could lead to errors in the data set. Meticulous data collection and analysis on a weekly basis, and collaboration with the department chair occurred to maintain data integrity. Overall, the QI project's outcome data remained consistent with the outcomes found in the extensive literature review conducted and with strategies geared to achieve the outcome goals.

Conclusions

To sustain the goals of this QI project, it will be imperative to continue educating providers, gain acknowledgment of the practice problem, and maintain buy-in from stakeholders. Presenting key stakeholders with the evidence of improvement in quality care and benefits the QI project provided for patients, will assist in garnering support for long-term sustainability. Additionally, providing evidence of the cost-effectiveness produced by the QI project will promote continuance of the initiatives and can garner financial support for ongoing necessary resources. Once buy-in is obtained, it must be retained with frequent communication of the project's progress, as well as opportunities for improvement. Providing continuous education and reminders to complete initiatives, is essential in a busy healthcare environment. Reminding staff of the importance in their roles to the successful continuation of the QI project, is imperative. The QI leader must be willing to listen to staff suggestions or concerns regarding the project initiatives. This feedback is essential for a successful project to have the support and eagerness of those participating. Strategically choosing Change Champions who have been with the organization for many years can be beneficial in several ways. They serve as mentors to many and are often welcomed by others for advice and recommendations. They can assist in targeting context-specific barriers such as employee resistance to change. The correct Change Champions will promote sustainability through continued example. Lastly, integration of the checklist into the EHR can promote sustainability over time by improving accountability and facilitating data collection. Additionally, improving the CA occurrence tracking system may facilitate data collection, leading to more accurate data and driving sustained change in the future. In conclusion, a QI project implementing a preoperative CA risk assessment and an intraoperative prevention protocol may improve the delivery of quality care and patient outcomes in the

perioperative period. This QI project could be used as a guideline by another institution and altered as needed to fit their setting based on resources available. Success of the QI project involved interdepartmental collaboration, engaging Change Champions, continuous education and leadership, and positive reinforcement.

References

Helfrich, C. D., Weiner, B. J., McKinney, M. M. & Minasian. L. (2007). Determinants of implementation effectiveness: Adapting a framework for complex innovations. *Medical Care Research and Review, 64*(3), 279-303. https://doi.org/10.1177/1077558707299887

Kocatürk, Ö., Kocatürk, T., Kaan, N., & Dayanır, V. (2012). The comparison of four different methods of perioperative eye protection under general anesthesia in prone position. *Journal of Clinical and Analytical Medicine, 3*(2), 163–165. https://doi.org/10.4328/jcam.607

Lenz, E. R, Pugh, L. C, Milligan, R. A, Gift, A., & Suppe, F. (1997). The middle-range theory of unpleasant symptoms: An update. *Advances in Nursing Science, 19*(3), 14-27. https://doi.org/10.1097/00012272-199703000-00003

Melnyk, B. M., & Fineout-Overholt, E. (2019). *Evidence-based practice in nursing & healthcare: A guide to best practice*. Wolters Kluwer.

Newhouse, R. P. (2006). Examining the source for evidence-based nursing practice. *JONA: The Journal of Nursing Administration, 36*(7/8), 337-340. https://doi.org/10.1097/00005110-200607000-00001

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: The Journal of Cornea and External Disease, 38*(7), 927-932. https://doi.org/10.1097/ICO.0000000000001972

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 Ophthalmology, 2014,* Article 901901. https://doi.org/10.1155/2014/901901

Vetter, T. R., Ali, N. M. K., & 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. *The Joint Commission Journal on Quality and Patient Safety*, *38*(11), 490-496. https://doi.org/10.1016/S1553-7250(12)38065-3

Table 1

Evidence Review for the Prevention of Perioperative Corneal Abrasions

Citation: Kocatürk, Ö., Kocatürk, T., Kaan, N., & Dayanır, V. (2012). The comparison of four different methods of perioperative eye protection under general anesthesia in prone position. *Journal of Clinical and Analytical Medicine*, *3*(2), 163–165. https://doi.org/10.4328/jcam.607					Level (*): II
Purpose/ Hypothesis	**Design**	**Sample**	**Intervention**	**Outcomes**	**Results**
The purpose of this study was to compare four perioperative ocular protection methods for patients placed prone during general anesthesia	RCT	**Sampling Technique:** Convenience **Eligible:** n=184 ASA I adult patients (368 eyes) undergoing spinal surgery GA for >90 min in the prone position **Included:** n= 184 Women: n=92 Men: n=92 **Excluded:** not detailed **Group Homogeneity:** homogeneous by maintaining baseline demographics and context similar between participants **Power analysis**: not detailed	**Control:** none **Intervention:** Patients were divided into four groups of 46 using a randomization chart. The groups were sex and aged matched. **Group 1:** hypoallergen adhesive tape (Hypafix®; Smith and Nephew, France) **Group 2:** antibiotic ointment (Terramycine®; Pfizer, Turkey) **Group 3:** artificial tear liquid gel containing polyacrylic acid (Viscotears®; Novartis, Turkey) **Group 4:** ocular lubricant pomade (Duratears®; Liba, Turkey). **Protocol:** Anesthesia protocol was standardized for all study patients. After the patients were	**DV:** severity of corneal damage, hyperemia of conjunctiva, chemosis **Measurement tool (reliability), time, procedure:** The ophthalmologist was blinded to the groups of patients and protection methods. Visual acuity, conjunctiva, and cornea were assessed by the ophthalmologist using fluorescein and Rose-Bengal staining. Patients were evaluated in preoperative period, in PACU, and at 12 and 24 hours after operation using the Schirmer-1 test, and for conjunctival edema and chemosis. A questionnaire form was used to evaluate for	**Level of Measurement:** Kruskal-Wallis test (followed by U-test) and Analysis of Variance with Bonferroni correction. **Statistical Results:** No eyes showed corneal epithelial defect preoperatively of the 368 eyes subjected to fluorescein and Rose-Bengal staining. There was a reduction in basal tear production postoperatively in all the four groups ($P<0.001$). Immediate postoperative examination in PACU revealed 12.77% of the overall incidence of corneal epithelial defects of which 2.72% occurred in Group 1 and Group 2, 5.16% in Group 3, and 2.17% in Group 4. **12 and 24 hours post-operative results** **Corneal epithelial defect:** Group 1 and Group 2: 10.86% Group 3: 20.65%

			intubated, the eye protection methods were performed according to the groups. All patients were turned prone, and their heads positioned in the neutral position with two pieces of silicone donut-shaped, 4 cm thick facial pad to prevent any extraocular pressure.	symptoms associated with CA.	Group 4: 8.69% **Conjunctival hyperemia:** Group 1: 13.04% Group 2: 15.21% Group 3: 22.82% Group 4: 15.21% **Chemosis observed:** Group 1: 17.39% Group 2: 26.08% Group 3: 33.69% Group 4: 22.82% **Group 3:** Mild intensity of corneal staining and with corneal lesion size of <1mm were significantly high in the PACU and at 12 and 24 hours after the operation than those of the other groups ($p<0.05$). Moderate and severe conjunctival hyperemia and itching were seen more frequently ($p<0.05$). After 12 hours, moderate conjunctival hyperemia was still high. **Group 1:** There was significantly less moderate chemosis than in other groups in PACU ($p<0.05$). Foreign body sensation were present ($p<0.05$). **Group 2 and 4:** blurred vision was high compared to other groups ($p<0.05$) **Conclusion:** all patient groups had reduced basal

					tear production of the eyes post-operatively. Artificial tear liquid gel containing polyacrylic acid (Viscotears®) produced the most corneal epithelial defects, hyperemia, and chemosis. Hypoallergen adhesive tape (Hypafix®) produced the least corneal epithelial defects, hyperemia, and chemosis. Blurry vision occurred most with antibiotic ointment (Terramycine®) and ocular lubricant pomade (Duratears®).
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. *The Journal of Cornea & External Disease*, *38*(7), 927-932. https://doi.org/10.1097/ICO.0000000000001972					Level (*): I
Purpose/ Hypothesis	**Design**	**Sample**	**Intervention**	**Outcomes**	**Results**
The purpose of this SR was to evaluate literature for risk factors, prevention, and treatment of perioperative corneal abrasions occurring in non-ocular surgery	SR with metanalysis, quantitative and qualitative data	**Sampling Technique:** used Preferred Reporting Items for Systematic Reviews and Meta-Analyses checklist and recommendation. Conducted a literature search using databases and Evidence-Based Medicine Reviews. Two investigators reviewed articles for inclusion and exclusion criteria. **Eligible:** n=51 perioperative corneal injuries after non-ocular surgeries only. English language articles with a title, abstract, and full text **Excluded:** n= 35; case	**Control:** varied between studies **Intervention:** varied between studies **Protocol:** not applicable for SR critique	**DV:** primary outcome of perioperative corneal injuries after non-ocular surgeries. **Measurement tool (reliability), time, procedure:** Two investigators reviewed the articles independently and reached a consensus on the data and the outcomes of the various studies. Analyzed similar study size, intervention	**Level of Measurement:** Meta-analysis of studies using the statistical software package SPSS v22.0. **Analysis:** Random effects modeling was used to calculate summary effect measures with corresponding 95% CI, and forest plots were generated. **Outcome Data Retrieval:** pulled data from all included articles

		reports and small case series with fewer than five patients. Review article (n = 20), duplicates (n = 3), trial (n = 3), basic science (n = 3), case report (n = 2), meta-analysis (n = 2), surgical technique (n = 1), response (n = 1), survey (n = 1), guideline (n = 1), and non-English text (n = 1). **Included/Accepted:** n=16 n=1 randomized control study (RCT) n=2 prospective nonrandomized studies n=1 retrospective study with historical controls n=1 meta-analysis n=1 hospital-based observational studies n=1 educational intervention trial n=9 retrospective case series **Quality of studies rated:** n=1 High quality n=13 moderate quality n=2 low quality **PRISMA:** detailed search strategy described and appropriately executed. Illustration provided for reference **Power analysis:** not applicable **Group Homogeneity:** Heterogeneous- The I^2 statistic was used to assess between-study heterogeneity. In some cases,		performed, complications, and outcomes. Articles were split into two categories, those that were epidemiological reports and those that were trials of different intervention	**Conclusion:** CA occurred at a cumulative rate of 0.64% of the 11 studies included in the meta-analysis. Most common associated risk factors identified included longer procedures, general anesthesia, and advanced age. Most common prevention techniques included eyelid taping with and without ointment and use of a bio-occlusive dressing such as Tegaderm. Two of the 16 articles evaluated educational interventions as means of CA prevention for which were able to demonstrate a statistically significant decrease in the rate of CA with the education alone. **SR Bias Risk:** lack of consistently reported sample sizes, variable forms of reported corneal abrasion rates, inconsistently reported patient demographics, and limited clinical trial data.

		the between-study heterogeneity was not significant and therefore the random effect modeling estimate equaled the fixed effects estimate.			
Citation: Segal, K. L., Fleischut, P. M., Kim, C., Levine, B., Faggiani, S. L., Banerjee, S., & Lelli, G. J. (2014). Evaluation and treatment of perioperative corneal abrasions. *Journal of ophthalmology*, *2014*, Article 901901. https://doi.org/10.1155/2014/901901					Level (*): IV
Purpose/ Hypothesis	**Design**	**Sample**	**Intervention**	**Outcomes**	**Results**
To evaluate perioperative risk factors, current care, and the time to diagnose and treatment corneal abrasions in a tertiary care setting	Retrospective review. Hospital-based, cross-sectional study.	**Sampling Technique:** Convenience **Eligible participants:** All patients from OR and PACU. Evaluated 78,542 surgical procedures over two years. Use of electronic medical record to collect data and downloaded data into the CA and control databases, respectively. **Included:** 86 cases of CA and 89 cases for controls **Excluded:** n=78,367 based on randomization from all surgical procedures for study period **Group Homogeneity:** heterogenous with various demographics	**Control:** patients who did not have a corneal injury in the perioperative period. Cohort was randomly selected using a computer-generated sample of all surgical patients from January 2007 to December 2008 who did not have a corneal injury in the perioperative period. Controls were unmatched to allow for statistical assessment of all possible risk factors for CA. Control cohort was not matched to the CA group by age, type of surgery, day of surgery, or anesthesia team. **Intervention:** patients with diagnosed post-operative CA.	**DV:** ocular injury after surgery **Measurement tool (reliability), time, procedure:** A password protected, HIPPA-compliant CA database was created to record all patients with perioperative eye injury and patients in the control group. Comparison of case records and controls were evaluated by analyzing demographic data including gender, race, height, weight, and age. Intraoperative factors were obtained including ASA status, surgical service, patient admission status, anesthesia type (general, MAC, local, or regional), operating room time, intubation type, patient position, eye protection,	**Level of Measurement:** All statistical tests were performed using R 2.10.0 statistical software. A chi-square test of association and a Wilcoxon's rank sum test was used as appropriate. *P* values for the chi-square test were calculated based on Monte Carlo simulations when contingency tables had low cell count. Cross-analysis on the groups was performed where appropriate. **Outcome data retrieval:** all surgical cases from January 2007 to December 2008 **Analysis:** CAs occurred at rate of 0.11% over two- years in 78,542 surgical procedures Statistically significant risk factors were age ($P = 0.0037$), general anesthesia ($P < 0.001$), greater average estimated blood loss ($P <$

			Corneal abrasion was diagnosed using clinical history and exam finding consistent with fluorescein uptake of the corneal epithelium. **Protocol:** varied between patients	estimated blood loss, and if CA occurred in the OR A Cross-analysis was performed when appropriate to further enhance the significance of comparisons of risk factors, treatment times, and treatments.	0.001), eyes taped during surgery ($P < 0.001$), prone position ($P < 0.001$), Trendelenburg position ($P < 0.001$), and supplemental oxygen en- route to and in the PACU ($P < 0.001$). **Conclusion:** CA occurred at a rate of 0.11% in 78,542 adult surgical patients. Statistically significant risk factors identified included advanced age, general anesthesia, greater blood loss, prone and Trendelenburg positioning, eyes taped during surgery, and supplemental oxygen en-route to PACU.
Citation: Vetter, T. R., Ali, N. M. K., & 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. *The Joint Commission Journal on Quality and Patient Safety*, *38*(11), 490-496. https://doi.org/10.1016/S1553-7250(12)38065-3					Level (*): IV
Purpose/ Hypothesis	**Design**	**Sample**	**Intervention**	**Outcomes**	**Results**
A CQI project with goal to achieve a sustained reduction in intraoperative corneal injury at an academic medical center	Case-Control Study Non-randomized, two- group time-series design, Seven-Step Problem-Solving Model	**Sampling Technique:** Convenience **Eligible:** 50,151 sequential general anesthetic cases before and 113,044 sequential general anesthetic cases after study period. **Group Homogeneity:** Homogeneous-preintervention and postintervention samples were clinically comparable in mean duration of anesthesia	**Control:** patients prior to study period that received general anesthesia **Intervention:** patients after study period that received general anesthesia **Intervention fidelity (describe the protocol):** two-step prevention method: (1) Eyes are	**DV:** Primary outcome measure: incidence of intraoperative corneal injury. Secondary outcome measure: compliance rate among anesthesia providers in documenting intraoperative patient eye protection. **Measurement tool (reliability), time,**	**Level of Measurement:** Control chart of special-cause variation of the two primary causes. A crude exposure odds ratio and its 95% CI were calculated for the occurrence of a corneal injury before and after implementation of the prevention program. A u-control chart was generated to track the monthly rate of patients diagnosed with a corneal injury. A time-

		ASA, lateral position, and percentage of head or neck surgery.	lubricated with aqueous-based gel (2) Application of two clear, square occlusive dressings that covers the entire eyelids and surrounding skin. Complete eyelid closure and corneal coverage is ensured. Both steps were to be consistently performed immediately after completion of airway management. Standardization of documentation for patient eye protection in the electronic anesthesia record via the use of a yes/no "hot key" for eye care and brief text narrative. Educational presentations and audiovisual materials were given at that time to all departmental anesthesia care team members to maximize awareness of the project intentions and interventions. Subsequent dissemination of information included quarterly CQI conferences and a	**procedure:** The occurrence of an intraoperative corneal injury under general anesthesia (delivered via an endotracheal tube or laryngeal mask airway) was documented using existing departmental quality assurance tracking methods.	series chart was generated to track electronic anesthesia records with patient eye-protection documentation. The significance of the observed differences in the corneal injury rate and documentation rate was assessed with a chi-square test. A $p < .05$ was considered significant. **Statistical Results:** The overall incidence of corneal injury was 1.20/1,000 general anesthetics before versus 0.09/1,000 general anesthetics after implementation of the prevention program ($p < .001$). The post- versus pre-implementation odds ratio for a corneal injury was 0.073 (95% CI, 0.038–0.14). Documentation of intraoperative patient eye protection increased from 3.4% to 74.9% during the most recent six-month period ($p < .0001$). **Conclusion:** Implementing of the intraoperative patient eye protection and the ongoing educational awareness program resulted in a significant decrease in monthly cases of corneal injury. A progressive increased in the rate of

			series of three anesthesia grand rounds. An online patient eye-protection protocol and video archive were made available to the anesthesia care team.		provider documentation was obtained. A simple cost-effectiveness analysis of the prevention program indicated a total direct medical cost of $80,261 (113,044 general anesthetics at $0.71/case) and a cost-effectiveness ratio of $637 per each of the approximate 126 corneal injuries prevented. **Bias:** Possible Hawthorne effect related to the persistent heightened awareness among the anesthesia providers in monitoring their adherence**.**

Note: American Society of Anesthesiologists Physical Status classification system (ASA), continuous quality improvement (CQI), confidence interval (CI), corneal abrasion (CA), monitored anesthesia care (MAC), Operating Room (OR), Post-Anesthesia Care Units (PACU), systematic review (SR), (*) Melnyk & Fineout -Overholt, 2019

Table 2

Synthesis of Evidence for the Prevention of Perioperative Corneal Abrasions

Evidence Based Practice Question (PICO): Does introducing standardized corneal abrasion prevention methods and risk assessment methods in adult surgical patients receiving general anesthesia in the prone position produce reduced occurrences of perioperative corneal abrasions compared to no standardization in prevention methods or risk assessments for corneal abrasions?			
Level of Evidence (Melnyk & Fineout-Overholt, 2019)	**# of Studies**	**Summary of Findings**	**Overall Quality** (Newhouse, 2006)
I	**1**	Papp et al., 2019 found that corneal abrasions occurred at a cumulative rate of 0.64% of the 11 studies included in the meta-analysis. Most common associated risk factors identified included longer procedures, general anesthesia, and advanced age. Most common prevention techniques included eyelid taping with and without ointment and use of a bio-occlusive dressing such as Tegaderm. Two of the 16 articles evaluated educational interventions as means of corneal abrasion prevention for which were able to demonstrate a statistically significant decrease in the rate of corneal abrasions with the education alone.	**B.** Extensive literature search, detailed, and reproducible. Detailed inclusion and exclusion criteria, and quality evidence ratings for included studies provided. Included sample size small, and no power analysis detailed. Generalizability of results possible due to heterogeneity. Appropriate statistical analysis conducted. Recommendations were clear with support of statistically significant results consistent with previous studies. Discussion of limitations included in the study.
II	**1**	Kocatürk, Ö., 2019 found that all patient groups had reduced basal tear production of the eyes post-operatively. Artificial tear liquid gel containing polyacrylic acid (Viscotears®) produced the most corneal epithelial defects, hyperemia, and chemosis. Hypoallergen adhesive tape (Hypafix®) produced the least corneal epithelial defects, hyperemia, and chemosis. Blurry vision occurred most with antibiotic ointment (Terramycine®) and ocular lubricant pomade (Duratears®).	**B.** sufficient sample sized obtained. Use of randomization but no control group used. Exclusion criteria and power analysis not detailed. Generalizability impeded related to homogeneous sample but avoids confounding variables. Results were consistent with other studies. Appropriate statistical analysis conducted. Intervention protocol clearly detailed with blinding of interventionalist. Recommendations were clear with support of statistically significant results. Discussion of limitations included in the study.
IV	**2**	Segal et al., 2014 found that corneal abrasions occurred at a rate of 0.11% in adult surgical patients. Statistically significant risk factors identified included advanced age, general anesthesia, greater blood loss, prone and Trendelenburg positioning, eyes taped during surgery, and supplemental oxygen en-route to the Post Anesthesia Care Unit.	**B.** sufficient sample sized obtained. Use of randomization of control group. Exclusion criteria not detailed but essentially based on randomization. Generalizability possible related to heterogeneous sample, but possible confounding variables. Appropriate statistical analysis conducted. Results were consistent with other studies. Recommendations were clear with

			support of statistically significant results. Discussion of limitations included in the study.
		Vetter et al., 2012 found that intraoperative patient eye protection and the ongoing educational awareness program resulted in a significant decrease in monthly cases of corneal injury. A progressive increase in the rate of provider documentation was obtained. A simple cost-effectiveness analysis of the prevention program indicated a total direct medical cost of $80,261 (113,044 general anesthetics at $0.71/case) and a cost-effectiveness ratio of $637 per each of the approximate 126 corneal injuries prevented.	**A.** large sample sized obtained. Credible clinicians from academic hospital conducting CQI. No randomization used, but well-designed study with detailed protocol and interventions. Generalizability impeded related to homogeneous sample but avoids confounding variables. Appropriate statistical analysis conducted. Results were consistent with other studies. Recommendations were clear with support of statistically significant results. Discussion of limitations included in the study.
Synthesis Summary: All studies found perioperative corneal abrasions to be the most common anesthesia-related complication in non-ocular surgery. Among studies, corneal abrasion rates were noted to be from 0.11 % and up to 59% (Kocatürk, Ö., 2019; Papp et al., 2019; Segal et al., 2014; Vetter et al., 2012). Generally, evidence suggest that standardized ocular protection, reporting, and education initiatives maximally decrease rates of perioperative CAs (Papp et al., 2019; Vetter et al., 2012). Papp et al. (2019) and Segal et al. (2014) found the most common risk factors for developing a corneal abrasion includes advanced age, dry eyes, ophthalmic history including glaucoma, cataracts, vision impairments (use of contacts, glasses, or blindness), and previous ocular surgery, receiving general anesthesia, lateral or prone positioning during surgery, equipment (oxygen use in route to PACU), longer procedures (>1 hour), and robotic surgery. Kocatürk, Ö. (2019), and Papp et al. (2019) found that ocular lubricants prior to taping is recommended for high-risk patients such as those with dry eye syndrome. They concluded that lubricants with preservatives lead to corneal abrasions and some lubricants may cause blurry vision coupled with eliciting a foreign body sensation, leading to corneal abrasions. Lastly, it was recommended based on significant evidence that the most common prevention techniques included eyelid taping using a bio-occlusive dressing such as Tegaderm. Vetter et al. (2012) found that corneal abrasion prevention leads to significant health care cost savings.		

Figure 1

Theory of Unpleasant Symptoms and Perioperative Corneal Abrasions

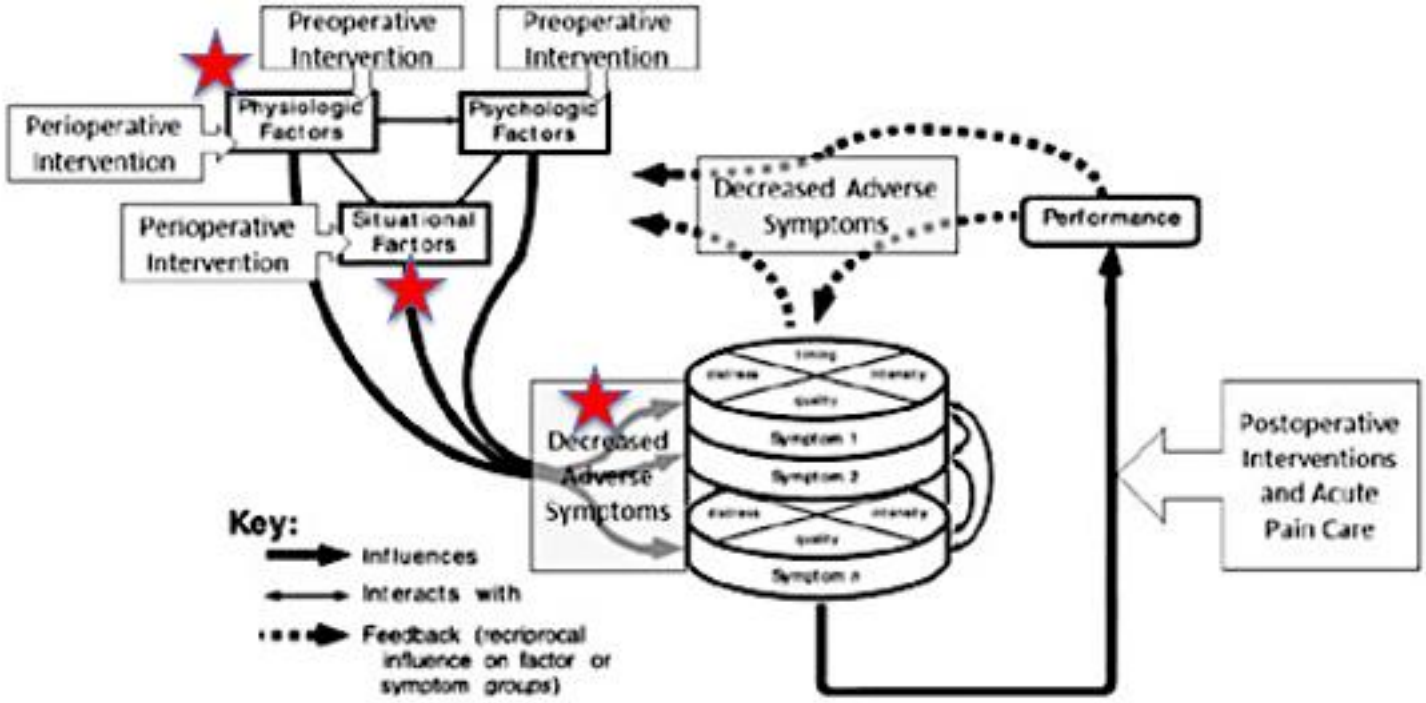
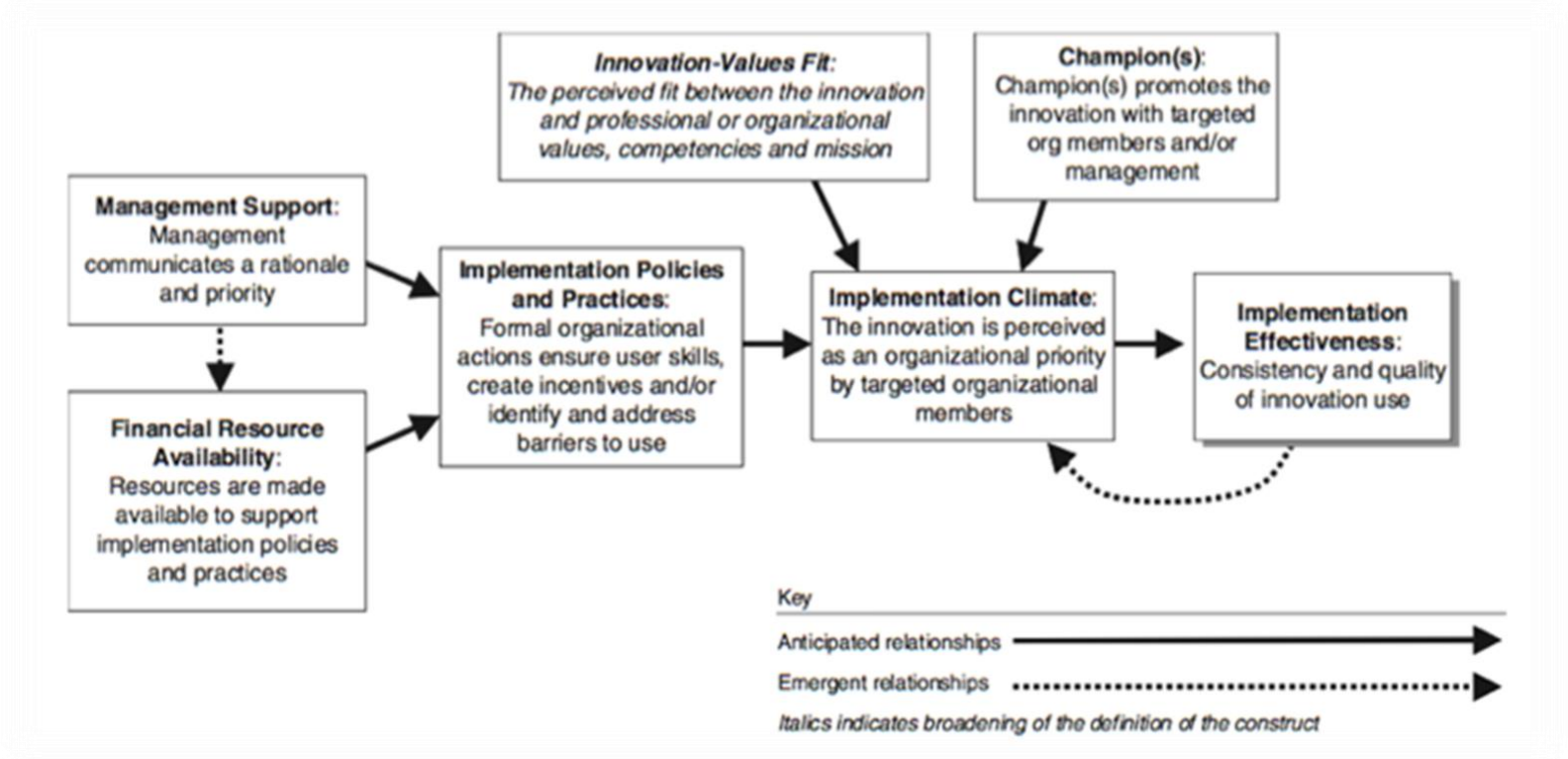


Figure 2

Helfrich's Implementation Framework for Complex Innovations



Appendix A

Process Maps

Figure A1

Process Map: Before QI Implementation for the Prevention of Perioperative Corneal Abrasions

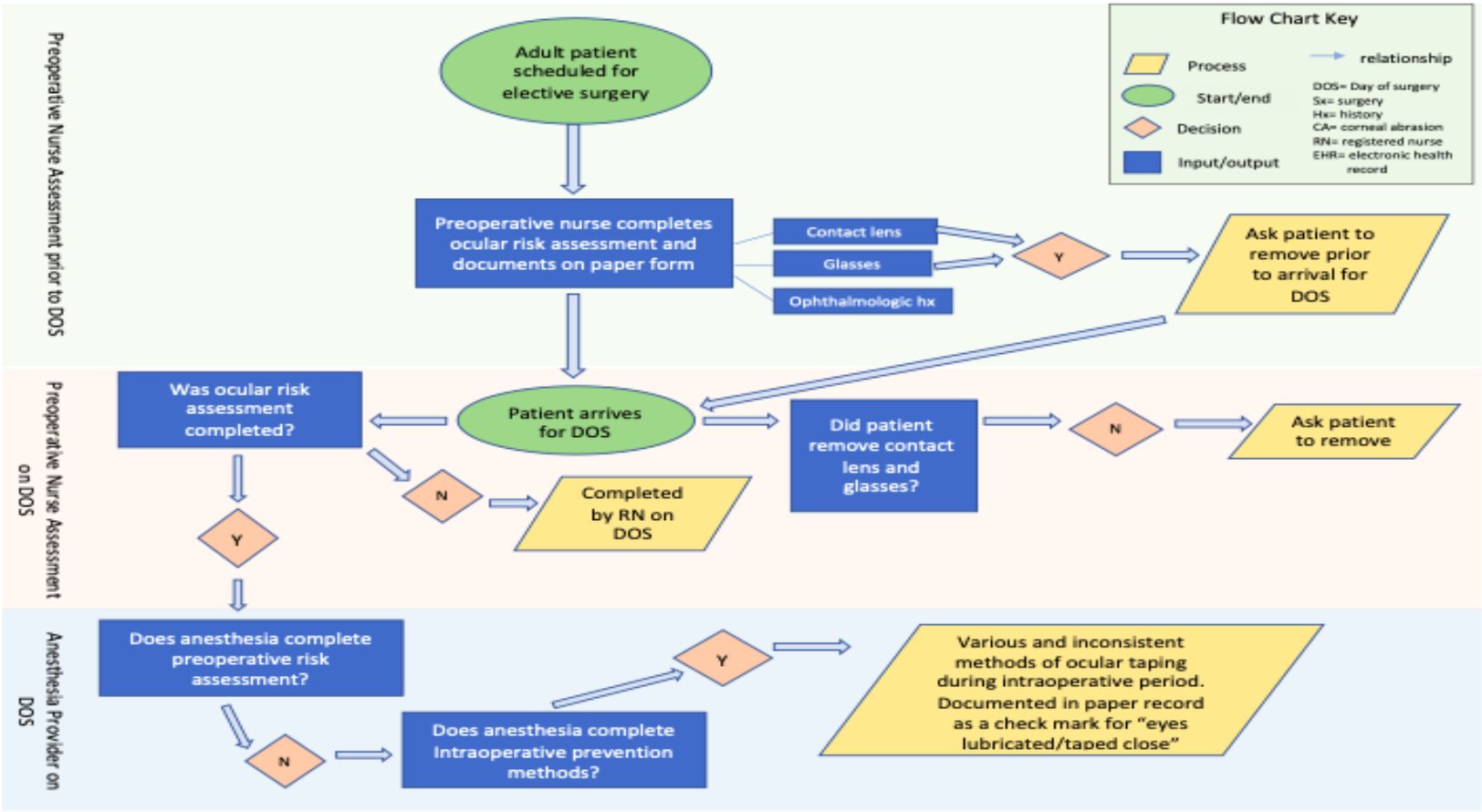
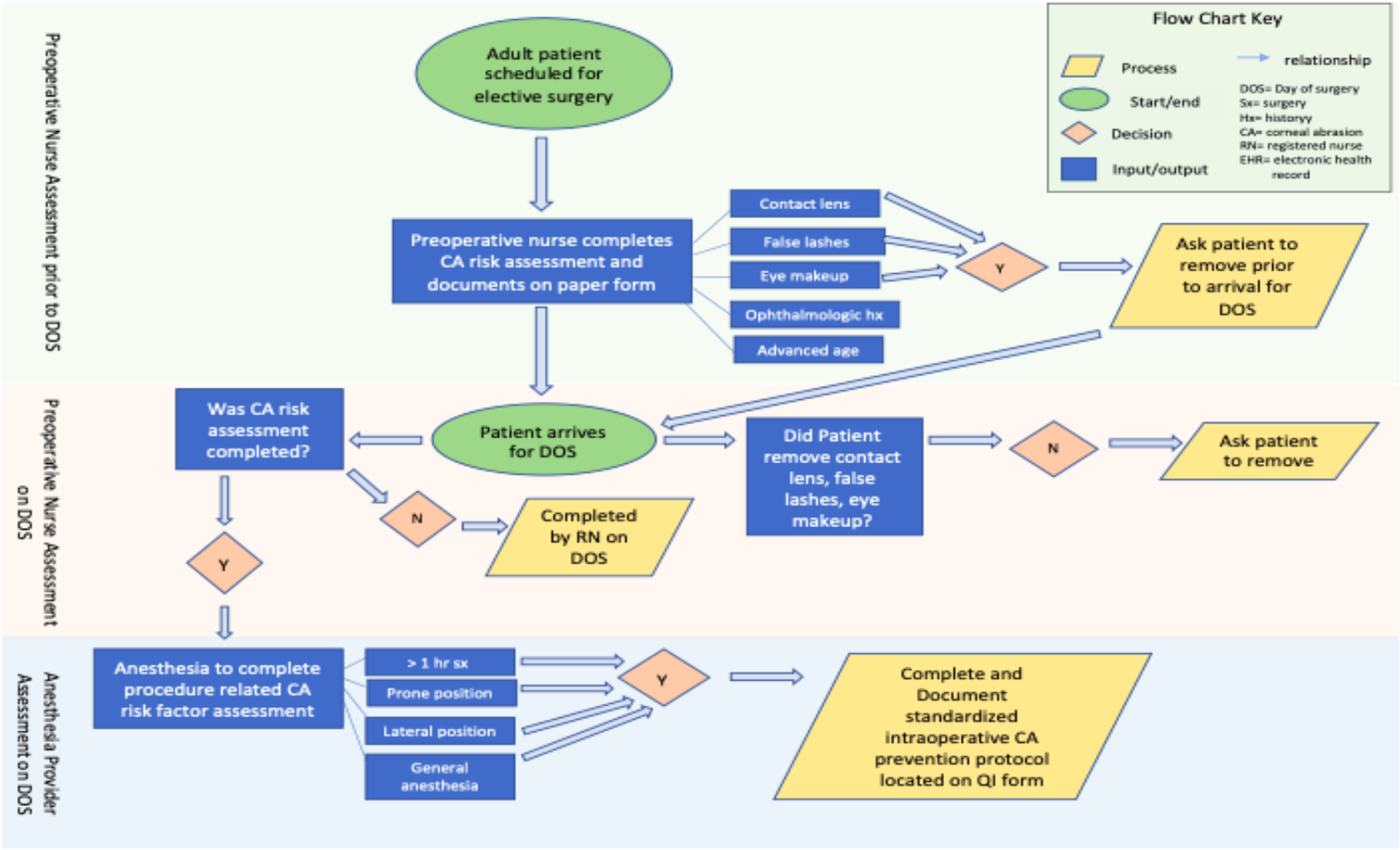


Figure A2

Process Map: After QI Implementation for the Prevention of Perioperative Corneal Abrasions



Appendix B

Implementation Tools

Figure B1

Preoperative Corneal Abrasion Risk Assessment

Preoperative Corneal Abrasion Risk Assessment

To be completed per preoperative Registered Nurse (Please circle Yes or No):

Preoperative CA Risk Assessment of Patient-Related Factors

[Yes/No] False Eyelashes
[Yes/No] Eye Makeup
[Yes/No] Glasses or Contacts
[Yes/No] Ophthalmologic History
[Yes/No] Dry Eyes
[Yes/No] Age 65+

To be completed per anesthesia provider (Please circle Yes or No):

Preoperative CA Risk Assessment of Procedure-Related Factors

[Yes/No] General Anesthesia
[Yes/No] Position (Prone or Lateral)
[Yes/No] Laparoscopic
[Yes/No] Duration >1 Hour

Figure B2

Intraoperative Corneal Abrasion Prevention Protocol

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

Patient Position

- ☐ Supine
- ☐ Prone
- ☐ Lateral
- ☐ Trendelenburg
- ☐ Reverse Trendelenburg
- ☐ Sitting

Induction

- ☐ Pulse oximeter- fourth finger of the non-dominant hand if appropriate
- ☐ Objects removed from provider's wrist/neck prior to induction
- ☐ Bio-occlusive ocular dressing applied to both eyes immediately after induction
  - ☐ Eyelids taped from upper eyelid towards lower eyelid
  - ☐ Eye lids are completely opposed and remain opposed
- ☐ Laparoscopic case? Yes/No (circle one)
  - ☐ Yes- Goggles placed

Emergence

- ☐ Ocular dressing removed prior to emergence
- ☐ Ocular dressing removed from upper eyelid towards lower eyelid

Appendix C

Data Run Charts

Figure C1

Run Chart: Completion of the Preoperative Risk Assessment

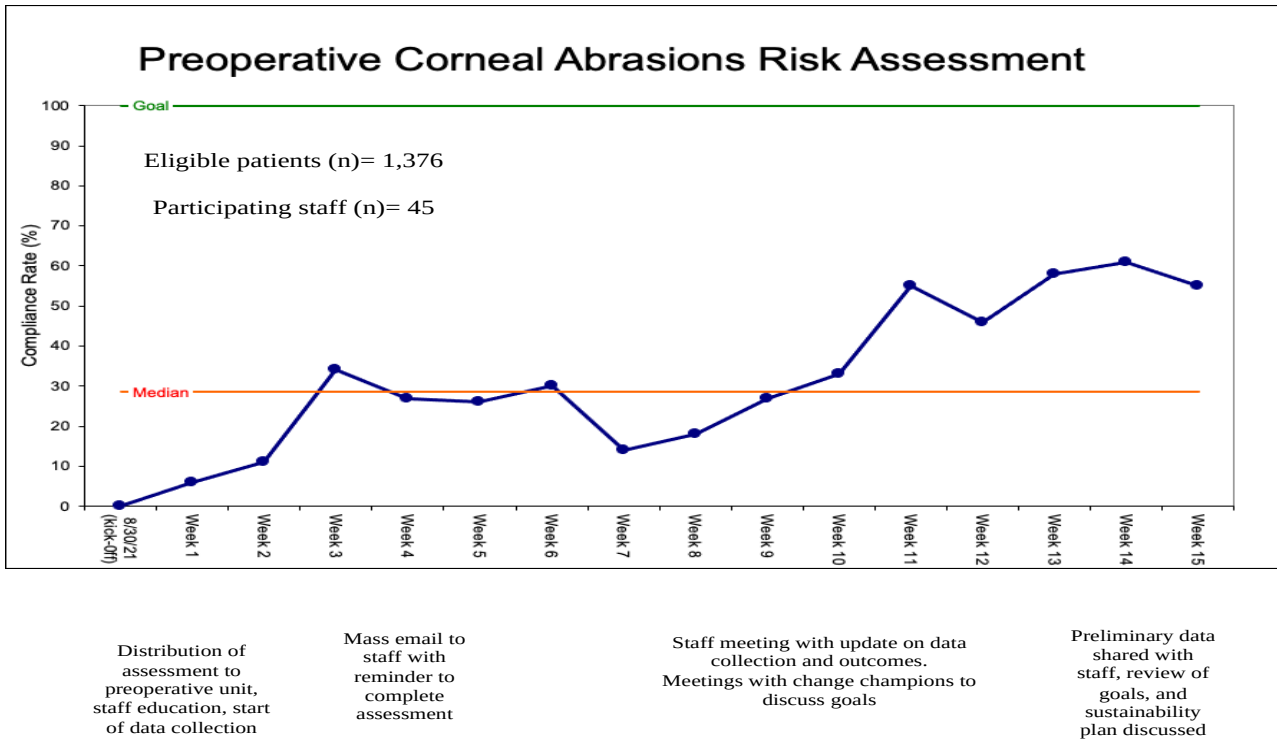


Figure C2

Run Chart: Completion of the Intraoperative Prevention Protocol

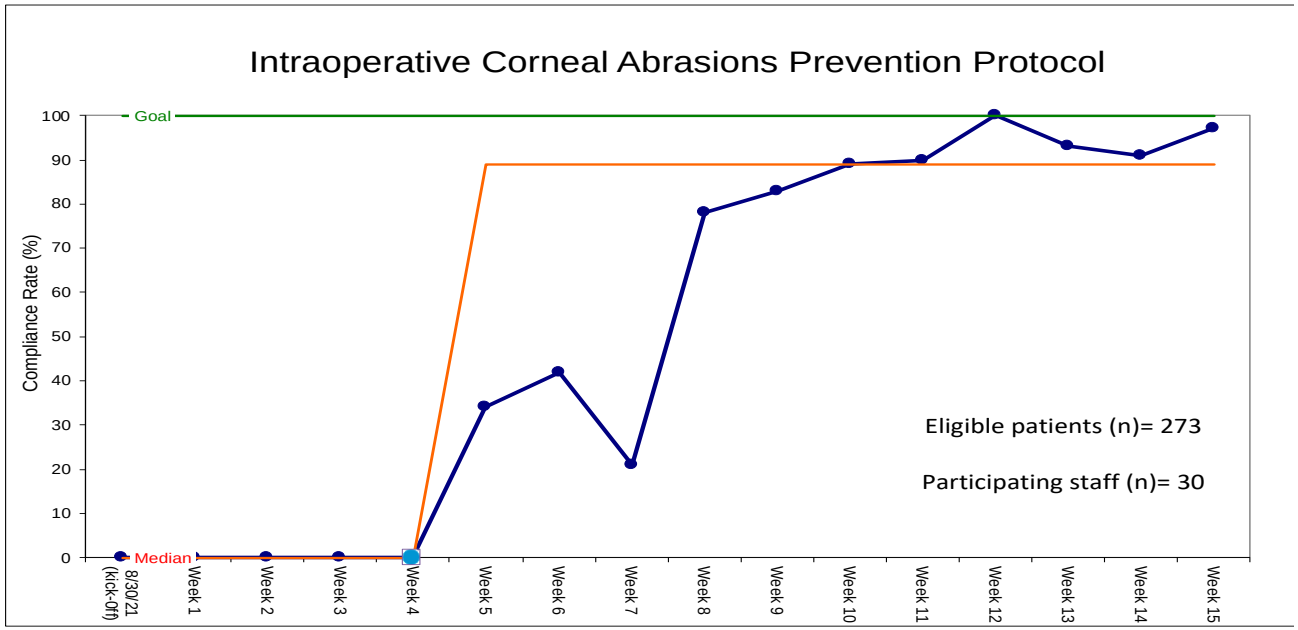


Figure C3

Run Chart: Perioperative Corneal Abrasion Occurrences