Implementation of an Intraoperative Prevention Protocol and Post-Operative Treatment for Corneal Abrasions

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

University of Maryland School of Nursing
May 2022

Abstract

Problem: The incidence of corneal abrasions (CAs) at a medium-sized urban community hospital in the Mid-Atlantic region of the United States occurs approximately three-to-five times per month. CAs are the most common ocular injury in patients undergoing general anesthesia for non-ocular procedures and are the result of mechanical, thermal, or chemical damage directly to the corneal epithelium. Development of a perioperative CA is incredibly painful for most patients, and poses the risks of keratitis, infection, corneal scarring, and vision loss. During general anesthesia, the normal protective reflexes of the eye become absent, further exposing the patient to injury. When the eyelid does not completely close, up to 44% of patients develop a CA. Evidence-based methods of eye protection such as taping the eyes closed, using goggles, methylcellulose-based lubrication, or gel drops during general anesthesia decrease the incidence of CAs to less than 0.02%. If a corneal abrasion is suspected, patients require eye patching, anesthetic eye drops, antibiotic ointment, and an Ophthalmologic consultation**. Purpose:** The purpose of this quality improvement (QI) project was to implement and evaluate an evidenced-based prevention plan and treatment algorithm for CAs, decreasing the number of ocular injuries and streamlining the treatment process in those patients who sustain a corneal abrasion. **Methods:** The anesthesia Quality Assurance (QA) documentation form was updated with a checklist for anesthesia providers to document CA prevention methods and patient positioning. Formal education was provided to the anesthesia department regarding current anesthesia practice recommendations, proper documentation, objectives and goals of the QI initiative. Data collection was achieved with weekly paper QA form audits. Data analysis was based on completion of the checklist on the QA form. **Results:** Documentation of CA prevention methods increased from 0% to a median of 80% during the 15-week implementation and data collection phase. Peak compliance reached 85% during week

nine. The rate of CAs decreased to zero and remained there for weeks 11-15. **Conclusions:** Implementation of an intra-operative CA prevention plan and documentation system decreased the number of corneal abrasions experienced at a medium-sized urban community hospital.

Implementation of an Intraoperative Prevention Protocol and Post-Operative Treatment for Corneal Abrasions

Corneal abrasions (CAs) are the most common perioperative ocular complication occurring in all patients undergoing general anesthesia (GA) for non-ocular surgery (Carniciu et al., 2016). CAs are the result of mechanical, thermal, or chemical damage directly to the corneal epithelium of the eye. The corneal layer is densely innervated with sensory fibers and is one of the most sensitive tissues in the body (Malafa et al., 2015). Development of a CA is incredibly painful for most patients, and poses the risks of keratitis, infection, corneal scarring, and vision loss (Carniciu et al., 2016). During GA, the normal protective reflexes of the eye become absent, further exposing the patient to injury. When the eyelid is not completely closed, up to 44% of patients develop a CA (Moos & Lind, 2006). Evidence-based methods of eye protection during GA decrease the incidence of CA to less than 0.02% (Antosh et al., 2012). Measures such as taping the eyes, use of eye goggles, methylcellulose-based lubrication, or gel drops prior to mask ventilation or intubation reduce the incidence of corneal abrasions. CAs require eye patching, anesthetic eye drops, antibiotic ointment and Ophthalmology consultation (Malafa et al., 2015).

The incidence of CAs, at a medium-sized urban community hospital in the Mid-Atlantic region, is approximately three-to-five per month. The monthly average of non-ocular surgical procedures requiring GA is approximately 500 at this facility, or 125 per week. When a CA is suspected, anesthesia staff must assess the patient and prescribe treatment modalities improving symptomology and preventing secondary eye damage. The current process for CA prevention and treatment is described in Appendix A. The purpose of this quality improvement (QI) project was to implement and evaluate an evidenced-based prevention plan and treatment algorithm for

CAs, decreasing the number of ocular injuries and streamlining the treatment process in those patients who sustain a corneal abrasion.

Literature Review

Four studies included in the evidence review show a positive outcome from standardized corneal abrasion prevention techniques and treatment methods. Two studies demonstrated the significance of corneal abrasion prevention techniques while the other two studies focused on early anesthesia-driven treatment modalities. All studies were hospital-based and focused on patients undergoing non-ocular GA. Evidence in all four studies was strong enough to support QI practice changes. Based on the Melnyk & Newhouse rating scales, one study was level III evidence and three studies were level IV evidence. Overall quality were mostly B ratings, with one article an A rating (Melnyk & Fineout-Overholt, 2019; Newhouse, 2006). Similarities and differences will be discussed below. Tables 1 and 2 can be referenced for more detailed evidence review and synthesis.

Wan et al., (2014) discovered using hydro-gel patches during GA in patients undergoing non-ocular surgery developed less corneal abrasion injuries than traditional adhesive tape. Thirty-nine and a half percent of 76 subjects in the adhesive tape group developed a corneal injury compared to only 15.8% in the hydro-gel patch group. Vetter et al., (2012) concluded implementation of an ongoing educational program regarding eye protection and documentation during GA, led to a decrease in the number of monthly corneal abrasions. Researchers reported there were 1.20 corneal abrasions per 1,000 surgeries prior to the intervention and 0.09 per 1,000 surgeries post-intervention. Eye protection documentation was 3.4% pre-intervention and 74.9% post-intervention. There was a cost-effective benefit of $637 for every corneal abrasion prevented in this study. Both studies provided similar outcomes regarding prevention.

Sample sizes were adequate to provide statistical significance in both studies analyzing corneal abrasion prevention. Randomization was not present in either study while heterogeneity of confounding variables was only present in one study. Vetter et al., (2012) was an exceptionally large study conducted at a major tertiary hospital with very rigorous protocols and led to clear recommendations for practice change. Wan et al., (2014) was a smaller study, yet yielded results in support of the practice change for corneal abrasion prevention. Both studies included thorough literature reviews prior to implementation.

Lichter et al., (2015) demonstrated minor corneal injuries following GA can be managed by an anesthesia provider. Implementation of an anesthesia-led protocol for treatment was initiated to decrease the amount of time to treatment and increase patient comfort and satisfaction. Anesthesia providers were able to successfully treat 92.33% of corneal injuries and decrease the time of treatment to an average of 177.84 minutes. Significant risk factors for corneal abrasions were determined to be advanced age and increased length of surgery. Segal et al., (2014) determined that 0.11% of patients developed a corneal abrasion based on significant risk factors. A treatment algorithm is presented in this study for post-anesthesia care unit nurses to initiate when a patient complains of a potential corneal epithelial injury.

The two studies analyzing anesthesia-led corneal abrasion treatment were both of sufficient sample size and quality to support the practice change. The study by Lichter et al., (2015) had an exceptionally large sample size, yet lacked a control group or randomization unlike Segal et al., (2014) that had a much smaller sample size but included randomization and blinding. Heterogeneity of confounding variables was present in the Segal et al., (2014) study leading to generalizability and relied on a strong literature review of best evidence for treatment

recommendations. Lichter et al., (2015) did provide strong enough evidence to suggest practice change, yet this was an observational study lacking prior statistics.

Theoretical Framework

Everett Rogers's Diffusion of Innovation Theory guided this implementation project as it refers to the process by which a new practice becomes a standard. Rogers, 2003 introduced five categories to guide how those in practice respond to and participate in change. Those identified as innovators and early adopters in the Diffusion of Innovation Theory are those who help to propel the desired change in practice. For example, innovators such as those proposing the change are risk takers, while early adopters desire to be role models and assist innovators in the implementation process among those who are more resistant to change. The implementer of this CA prevention and treatment project was the innovator while change champions were considered early adopters of the implementation plan (Rogers, 2003). Early adopters were motivated to change with education regarding the importance of CA prevention and the current best methods from the literature review. Overcoming resistance was accomplished by re-educating practitioners on the importance of documenting CA prevention methods that are provided to perioperative patients. If a patient were to sustain a CA, documentation of proper prevention methods could help to prove the CA may not have been caused perioperatively.

Helfrich et al., (2007) describe an organizational implementation Framework of Complex Innovations that applies to implementation within the health sector utilizing multiple members to create an innovative change. Two major characteristics of this framework focus on the cumulative effect of the individuals involved in the implementation-climate at the organizational level, and the overall effectiveness of the implementation. This framework was applied to the CA prevention and treatment project as it describes how adoption of an innovation, or a new

practice, overcomes resistance with the use of an innovation champion and how the implementation-climate can be molded by other team members to reach a successful outcome. Change champions directly encouraged anesthesia providers in the operating room to utilize the CA prevention materials provided and document prevention methods. Educational interventions provided by the Doctor of Nursing Practice QI Project Lead (QI PL) ensured anesthesia providers understood the practice changes being implemented, while also having the ability to ask questions. Effectiveness of the intervention was measured by the innovation champion, the QI-PL, using quantitative metrics to show aggregate consistency of the intervention (Helfrich et al., 2007). Figure 1 and Figure 2 highlight the implementation and QI frameworks.

Methods

The corneal abrasion QI project took place within a 20-bed operating room suite and a post anesthesia care unit (PACU) of 15 patient bays. Approximately 20-25 patients per day underwent procedures and recovered in the PACU, which consisted of ten nurses per shift. Four physician anesthesiologists (MDAs) and 10-12 Certified Registered Nurse Anesthetists (CRNAs) typically cover the perioperative units each day alongside 3-4 Student Registered Nurse Anesthetists. Over a period of 15-weeks from August through December of 2021, the QI project impacted approximately 1,875 patients over 18 years-old, undergoing non-ocular surgery requiring GA. Pediatric patients and those undergoing emergent surgical procedures were excluded from data collection and analysis. Patients requiring interpreter services and those with vision, hearing, or developmental deficits were provided with the appropriate resources to receive the perioperative prevention interventions and treatment, as necessary. The evidence-based interventions implemented were a CA prevention protocol, which was added to the anesthesia Quality Assurance (QA) sheet, as seen in Appendix B, and a CA treatment order-set

added into the electronic medical record (EMR) for one-click provider order entry, as seen in Appendix C. Patients requiring interpreter services and those with vision or hearing deficits were provided with the appropriate resources to receive the perioperative prevention interventions and treatment, as necessary**.**

The QI-PL collected data utilizing a data management tool (Appendix D), which was collected on a personal password protected device. Data was collected aggregately on a weekly basis by the QI-PL and was not connected to demographical patient data. Data collection focused on the weekly compliance rate of the CA protocol documentation on the anesthesia QA sheet (see Appendix D). The goal for tracking the weekly number of corneal abrasions was to be accomplished by an Information Technology (IT) department audit to determine the number of times the CA order-set was used in the EMR. This was not accomplished as the CA order-set was not published in the EMR. All data collection tools were kept in a locked, secure location in the anesthesia office on-site. Confidentiality was assured utilizing laws outlined by the Health Insurance Portability and Accountability Act.

Results

The goals of this QI initiative were to increase corneal abrasion prevention methods while achieving 100% documentation compliance, decreasing the monthly number of CAs to zero, and adding a CA treatment order-set into the electronic provider order-entry system. During the 15-week implementation and data collection phase, the compliance rate of CA documentation for patients in the supine, sitting, Trendelenburg, and reverse Trendelenburg positions increased steadily from a compliance rate of 0% to a median of 80% during week eleven. During week nine, the peak compliance rate was observed at 85%. There was a run from weeks one-through-four representing 0% compliance, and another run from weeks seven-

through-15 showing greater than 60% weekly compliance. The incidence of CAs decreased from a median of one, to a median of zero in week twelve. During weeks 11-15 there were no suspected or confirmed CAs.

The updated anesthesia QA forms began circulating in the perioperative anesthesia documentation packets at the beginning of week-four. During week-seven, formal education was provided to the anesthesia team regarding the objectives, goals, and documentation compliance expectations relating to corneal abrasion prevention. Barriers to implementation efforts posed challenges in achieving the desired goals. There was a delay in printing the new QA documentation forms that included the prevention checklist, while scheduling conflicts hindered the ability to complete formal education at the weekly anesthesia departmental meeting. The one-click treatment order-set was designed and ready to be put into production, however, during the final approval process, hospital administration made the decision to create a hospital wide CA treatment order set which superseded the departmental QI initiative. At the beginning of implementation, the hospital acquired more resources to aid in corneal abrasion prevention, such as bio-occlusive eye dressings, which were facilitative in increasing prevention efforts. Utilizing change champions and providing intermittent informal education and compliance updates at weeks 4, 7, 9, 11, and 13 helped to propel the desired change throughout the 15-week implementation phase.

Discussion

The benchmark of 100% compliance with CA prevention documentation was not achieved during the 15-week implementation and data collection phase. However, the QI initiative showed a steady increase in the compliance rate overall. The anesthesia department within this facility was seeking to improve their current system for CA prevention methods,

documentation of compliance of such methods, a formal treatment order-set, and an improved system for tracking monthly CA occurrences. Implementation of the prevention protocol was able to demonstrate results similar to Antosh et al., (2012), that showed proper prevention methods decreased the rate of CAs to less than 0.02%. Vetter et al., (2012) state the implementation of a CA protocol focusing on prevention documentation increased documentation compliance from 3.4% to 74.9%. Comparable results were yielded at this facility with the steady increase from 0-85% documentation compliance post-implementation.

The CA QI project provided several necessary building blocks to continue the development of CA prevention, treatment, and departmental data collection tools and processes at this facility. CA prevention is part of the standard of care in anesthesia practice. The documentation tool added to the QA sheet allows anesthesia providers to formally document, or show proof, that a certain level of care was provided. More precise monitoring of the CAs was to be achieved using a monthly computerized report from the IT department regarding the number of times the electronic provider order-entry treatment order-set was used, but was delayed while awaiting the hospital CA order set creation. Less precise monitoring via email correspondence with anesthesia department members was utilized for the purpose of data collection during this 15-week period. Paper auditing of charts was the primary method of determining CA prevention documentation compliance. There was no way to avoid paper auditing due to the current documentation system in use at this facility. Major barriers to benchmark achievement stemmed from long waiting periods to receive requested materials and scheduling difficulties to provide earlier education. If the updated QA form circulated on August 30, 2021, then formal education could have been provided sooner, allowing for more re-education and follow-up and potentially higher rates of compliance during the 15-week implementation. Including the hospital wide

committee earlier in the CA treatment order-set formation could have led to the treatment order-set achieving final approval and entering production during the 15-week implementation and data collection phase. Utilizing more face-to-face communication during the process would have created for a stronger project design and plan, however this was limited due to scheduling, ability to be present at the facility, and implications from the COVID-19 pandemic.

Conclusions

Improved patient outcomes were a result of this CA QI initiative. The rate of CA documentation compliance increased, showing that during a given week, up to 85% of anesthesia providers were completing the recommended prevention methods and documenting proof of such care. The overall rate of CAs decreased from a peak of two and a median of one, to a five-week run with no reported corneal abrasions. Although there were barriers to the implementation of this project, the outcomes were anticipated based on current literature, and showed the desired outcomes.

The strengths of this project included the addition of the documentation checklist, formal education on current best practices for CA prevention methods, and a plan for a formalized provider order-entry treatment protocol for patients who sustain a corneal injury. Sustainability of these initiatives would be best accomplished by adding the prevention checklist and treatment order-set into the electronic medical record. This would allow for computer-generated analysis of the compliance of CA prevention methods while comparing the monthly occurrence rates of injury. Creation of a one-click treatment order-set streamlines the process while providing the most current evidence-based treatment modalities. Overall, the practice implications associated with a comprehensive CA prevention protocol and treatment plan is improved patient care and satisfaction.

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Wan, T., Wang, Y., & Xiu-Ming 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

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

Tables

Table 1

Evidence Review Table for Corneal Abrasions

Citation: Lichter, J. R., Marr, L. B., Schilling, D. E., Hudson, M. E., Boretsky, R. H., Barad, R. F., & Chelly, J. E. (2015). A Department-of-Anesthesiology-based management protocol for perioperative corneal abrasions. Clinical Ophthalmology 9, 1689–1695. https://doi.org/10.2147/OPTH.S84367					Level: IV (Melnyk & Fineout - Overholt, 2019)
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
"Corneal abrasions (Cas) are the most prevalent ocular injuries in the perioperative period. Previously, patients at our community hospital would wait for an ophthalmologist to be available to manage these minor injuries. To decrease this waiting period – and thereby increase patient satisfaction – we developed an anesthesiology-based protocol to manage minor Cas arising in the recovery room. The current study sought to assess this protocol's efficacy as well as further establish the incidence and some risk factors of CA" (p. 1689).	Hospital-based, observational study from (03/2007-12/2011) funded by the University of Pittsburgh in Pittsburgh, Pennsylvania. IRB-approved medical record review.	**Sampling Technique:** Convenience sampling. **# Eligible**: All adult patients undergoing a non-ocular surgical procedure. **# Excluded**: Pediatric and obstetric patients. **# Accepted**: 171 out of 91,064 non-ocular procedures. **# Control**: No control group was utilized in the observational study. **# Intervention**: 118 patients. **Power Analysis**: N/A for this study. **Group Homogeneity**: Demographical data showing homogeneity was not statistically presented in this study. Review of patient age and length of surgery were presented in Figure 3. Advanced age and longer duration of surgery showed homogeneity.	**Control**: There was no designated control group for this observational study. **Intervention**: The intervention group consisted of 171 patients who had eye complaints in the PACU. 118 patients were diagnosed with a CA by anesthesia providers. **Intervention Fidelity**: An Anesthesiologist-led protocol for simple CA identification was implemented to decrease time to diagnosis and treatment for the patient. Ophthalmology was available for consult within 24 hours for more difficult cases. A treatment algorithm was available in Table 2 of the study results.	**DV**: Decreased time to diagnosis and treatment of CA and faster pain relief for the patient. **Measurement tool (reliability), time, procedure:** Time to treatment with the protocol was recorded in minutes from the time anesthesia ended to the time the nurse gave the first eye medication. No tool or instrument was used to determine reliability or inter-rater reliability.	**Statistical Procedure(s) and Results:** R version 3.0.1 software was used to analyze results. Shapiro-Wilk test: utilized to determine the normality of the data. Alpha was used with a 95% Confidence Interval. Mann-Whitney *U*-tests: compared age and duration of surgery between CA patients and non-ocular injury patients. Anesthesiology alone was able to treat 92.33% of patients that were diagnosed with CA. All patients who received the anesthesia-led protocol treatment had relief of symptoms within 24 hours. Those diagnosed with CA were significantly

					older (P<0.01) with the average age of diagnosis 64.49 years compared to those without injury at 58.1 years. Surgical duration was found be significant (P<0.01) with CA patients undergoing an average of 207.93 minutes versus 132.73 minutes in the uninjured. The average time to treatment of CA in this study was less than three hours, while it typically takes 1-3 hours for the symptoms of CA to present. This means anesthesia-led protocols are very effective in quick and attentive treatment of Cas.
Citation: Segal, K. L., Fleischut, P. M., Kim, C., Levine, B., Faggiani, S. L., Banerjee, S., Gadalla, F., & Lelli Jr., G. J. (2014). Evaluation and Treatment of Perioperative Corneal Abrasions. Journal of Ophthalmology, 1–5. https://doi-org.proxy-hs.researchport.umd.edu/10.1155/2014/901901					Level: IV (Melnyk & Fineout - Overholt, 2019)
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
"To evaluate perioperative risk factors for corneal abrasion (CA) and to determine current care for perioperative CA in a tertiary care setting." (p. 1).	IRB-approved medical record review. Hospital-based, cross-sectional, case-control study at New York-Presbyterian Hospital in New York, New York from (1/1/2007–	**Sampling Technique**: Convenience sampling. **# Eligible**: All patients who were diagnosed with a post-operative CA who underwent a surgical procedure requiring anesthesia.	**Control**: A cohort was randomly selected from all procedures that occurred in which the patient did not sustain a CA. 89 patients were randomly selected for this cohort.	**DV:** Improved management of CA via decreased time to treatment of CA, increased patient satisfaction, and decreased usage of	**Statistical Procedures(s) and Results:** R 2.10.0 software was used for statistical analysis in this study. A chi-square test was used to determine statistical

	12/31/2008). IRB-approved retrospective review of medical records on all patients who sustained a CA.	**# Excluded**: No exclusion criteria. 78,367 not utilized in review. **# Accepted**: 175 out of 78, 524 of surgical procedures performed over two years. **# Control**: 89 **# Intervention**: 86 **Power analysis**: Due to the small percentage of Cas in comparison to number of general anesthesia procedures, power cannot be established for a prospective study. Power analysis N/A for this study. **Group Homogeneity**: Statistically significant risk factors are presented by P values in Table 2 showing heterogeneity among the case and control groups. Demographic data in Table 1 also proved heterogeneity with significant P values.	**Intervention**: 86 patients were identified to have a CA during the perioperative period. **Intervention fidelity (describe the protocol):** Computerized software was utilized to un-match confounding variables in the control group. An algorithm was created for care of Cas in the post-anesthesia care unit (PACU) with a stepwise approach seen in Figure 1. Anesthesia staff was trained by Ophthalmologists to detect a CA as well as how to properly administer medication into the eye. At New York-Presbyterian Hospital the algorithm was implemented as a treatment protocol by anesthesia staff in the PACU. Figure 1 offers the treatment algorithm followed once a patient complains of a potential corneal injury. This algorithm is used to guide the treatment process and follows a stepwise approach.	unnecessary medical equipment. **Measurement tool (reliability), time, procedure**: Case-control records were analyzed using a password protected software system to compare confounding variables such as: age, gender, height/weight, type of surgery, anesthesia type, patient position, eye protective methods, blood loss, duration of anesthesia, and level of comorbidities. Further studies are required to determine the reliability of the protocol. No data was provided for post-implementation evaluation. The algorithm implementation will need to be studied for significance post-intervention. No inter-rater reliability is available.	significance among risk factors and demographic data. Wilcoxon's rank sum test and Monte Carlo simulations were used to produce P values. Table 2 presents statistically significant risk factors and includes: Trendelenburg position, urological surgery, same day admission, general anesthesia, prone position, eyes taped during surgery, estimated blood loss, main PACU recovery, and oxygen use during transport. Table 3 presents perioperative factors such as: time to complaint, time to consult, ophthalmology consult, and long-term sequalae as percentages. Table 4 presents the common treatments for CA. Caucasian race and female gender were found to be significant risk factors also. Overall, only 86 out of 78,542 patients developed corneal abrasions at a rate of 0.11%.

Citation: Wan, T., Wang, Y., & Xiu-Ming 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					Level: III (Melnyk & Fineout - Overholt, 2019)
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
"To evaluate corneal injury during general anesthesia and analyze the protective effect of medical hydro-gel eye patch in clinics," (p. 964).	Double-blinded, prospective study	**Sampling Technique**: Convenience sampling. **# Eligible**: Consecutive patients undergoing general anesthesia with endotracheal tube placement during non-ocular surgery. Ages 17-80. American Society of Anesthesiologists physical status 1-3. Time of surgery was anticipated to be 60-300 minutes. **# Excluded**: Patients with severe systemic disease, positive Fluorescein-staining of the cornea, those allergic to Fluorescein or oxybuprocaine, and those unable to meaningfully communicate with investigators. **# Accepted**: 76 patients with 152 eyes for investigation **# Control**: 76 **# Intervention**: 76 Power Analysis: Not presented in the research article methods.	**Control**: 76 eyes; one eye from each patient was randomly selected for standard adhesive tape. **Intervention:** 76 eyes; one eye from each patient was randomly selected for the hydro-gel patch. **Intervention Fidelity:** All participants were given an informed consent. Anesthesia providers used a standard protocol, and all monitors were applied in accordance with current practice. Each patient had both eyes evaluated prior to random allocation of their two eyes into the control and intervention groups. Computer-generated software was used to allocate the intervention and control subjects. Intravenous anesthetic agents were constant: etomidate, esmeron, midazolam, remifentanil, and propofol. Providers were instructed on how	**DV:** Decrease the number of corneal abrasions during supine surgery in those undergoing general anesthesia. **Measurement tool (reliability), time, procedure:** The dependent variable was measured using corneal staining with Fluorescein by an Ophthalmologist immediately after surgery and 24 hours post-operatively. Patients answered a questionnaire to determine their level of eye discomfort post-operatively. Outcome measures were presented based on a grading scale from the Ophthalmologist's corneal screening and patient questionnaire. There was no reliability data, inter-rater reliability was not available.	**Statistical Procedures(s) and Results:** Results were analyzed using SPSS software (version 16; Chicago, IL, USA). Percentages were used to demonstrate the amount of corneal injury. In the control group, using adhesive tape, 30 eyes or 39.5% of the subjects sustained ocular injury after surgery. Using the hydro-gel patch only 12 eyes, or 15.8% had an ocular injury. The usage of hydro-gel patching was proven significant with a P-value <0.01. Eye discomfort was seen in four patients in the intervention group and six patients in the control group. A score of 1-2 from the patient questionnaire was considered a positive screen for eye discomfort. A P-value of 0.257 showed there was no significant difference in the level

		Group Homogeneity: Homogeneity is shown with rigorous control of independent variables in the exclusion and inclusion criteria. Demographic data is not presented, which could lead to group heterogeneity. However, the article did state the following was recorded: diagnosis, length of anesthesia, comorbidities, demographic data, and type of surgery.	to place the patch, to ensure the eyelid was completely shut, and to apply the eye protection immediately following loss of the eyelid reflex. Temperature was held constant at 24 degrees Celsius and humidity at 55% during all procedures. Only supine positioning was accepted as part of the study. Ophthalmologists were blinded to the intervention and control groups and evaluated each eye after surgery. Corneal Fluorescein staining was used to grade damage to the epithelium.		of eye discomfort experienced. Additionally, no side effects were present in the hydro-gel group. Two patients experience eye itching, and five patients developed brow avulsion in the adhesive tape group. Figures 2, 3, and 4 represented statistical analysis.
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					Level: IV (Melnyk & Fineout - Overholt, 2019)
Purpose/ Hypothesis	Design	Sample	Intervention	Outcomes	Results
"In this review, the etiology of peri-operative corneal abrasions is discussed, and various protection strategies are compared in order to identify the best methods to prevent corneal abrasions following general anesthesia" (p. 490).	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 post-implementation	**Sampling Technique**: Convenience sampling. **# Eligible**: All sequential general anesthetics. **# Excluded:** None. **# Accepted:** 163,195 **# Control:** 50,151 **# Intervention**: 113,044	**Control:** All general anesthesia cases from 12/01/2005-09/30-2007. This was prior to the CQI project implementation. **Intervention:** Post-implementation of a standardized eye-protection protocol for CA prevention.	**DV:** Decrease the number of intraoperative corneal injuries and increase the documentation of preventative strategies for corneal abrasion and those whose sustained a perioperative corneal injury.	**Statistical Procedure(s) and 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.

	(10/01/2007-06/30/2011). Nonrandomized, two group time-series using the Seven-Step Problem-Solving Model.	**Power Analysis:** N/A to case control study. **Group Homogeneity:** All independent variables were comparable between the pre-and-post intervention groups to include lateral positioning, duration of anesthesia, American Society of Anesthesiologists physical status, and percentage of head and neck surgery.	**Intervention Fidelity:** Electronic medical record documentation of new treatment protocol was recorded and the improvement in documentation was shown in Figure 6. Randomized observation of individual practitioner's eye protection methods. Hawthorne effect contributed to adherence in the new eye-protection policy. Rigorous documentation education presented by the CQI committee. A two-step prevention method was completed with an aqueous-based eye gel and clear occlusive dressings over the eyes.	**Measurement tool (reliability), time, procedure:** Documentation of eye protection and intraoperative corneal injuries were obtained from the electronic medical record for analysis. Corneal injury was tracked using current departmental quality assurance practices. Reliability was not tracked with an instrument or tool. Inter-rater reliability was also not available in this study.	Time-series chart tracking electronic medical records with eye protection documented. Chi-square test to determine significance of the prevention methods using $P<0.05$. There were 58 corneal abrasions identified in the control group and only 10 in the intervention group. Duration of surgery, American Society of Anesthesiologists physical status, lateral patient positioning, and percentage of head and neck surgery were compared using standard deviation and reported to be insignificant.

Table 2
Synthesis Table

Evidence Based Practice Question (PICO): Does implementation of a standardized corneal abrasion prevention protocol and treatment algorithm for adult surgical patients undergoing non-ocular surgery receiving general anesthesia in the supine position decrease the risk of developing perioperative corneal abrasion and increase corneal injury recovery in comparison to individual anesthesia provider corneal prevention techniques and treatment methods for corneal epithelial injury?			
Level of Evidence (Melnyk & Fineout-Overholt, 2019)	**# of Studies**	**Summary of Findings**	**Overall Quality** (Newhouse, 2006)
III	**1**	Ting Wan et al., 2014 discovered that the use of a hydro-gel patch during general anesthesia in patients undergoing non-ocular surgery in the supine position developed less corneal abrasion injuries than traditional adhesive tape. 39.5% of 76 subjects in the adhesive tape group developed a corneal injury compared to only 15.8% in the hydro-gel patch group. Statistical significance proves the benefit of using the hydro-gel patch for prevention of corneal abrasion.	**B.** The sample size was sufficient to provide consistent results. The design was not randomized; however, the study was double-blinded. Control and intervention groups were randomly assigned with computer generated software. Literature review of current anesthesia practices was evident throughout the study design and methods. Statistical analysis was sufficient to provide definitive results. Heterogeneity was not presented using demographic data, type of surgery, and comorbidities of study subjects. Generalizability can be applied due to the broad nature of the research design. Sample sizes were adequate to provide statistical significance in both studies analyzing corneal abrasion prevention. Randomization was not present in either study while heterogeneity of confounding variables was only present in one study. Vetter et al., 2012 was a very large study conducted at a major tertiary hospital with very rigorous protocols and led to clear recommendations for practice change. Ting Wan et al., 2014 was a much smaller study, yet yielded results that are in support of practice change for corneal abrasion prevention. Both studies included very thorough literature reviews prior to implementation.
IV	**3**	Lichter et al., 2015 demonstrated that minor corneal injuries following general anesthesia can be managed by an anesthesia provider when ophthalmology consult is not readily available. During this study, an anesthesia-led protocol for treatment was implemented to decrease the amount of time to treatment of corneal abrasion and increase patient comfort and satisfaction. Anesthesia providers were able to successfully treat 92.33% of corneal injuries and decrease the time of treatment to an average of 177.84 minutes. Significant risk factors for corneal abrasions were determined to be advanced age and increased length of surgery.	**B.** This study had a large sample size and provided consistent results to support a practice change. There was no control group included in the study. There was no randomization or blinding to the study. This was an observational study that focused on the results of an implemented protocol and lacked prior statistics. The results were definitive based on extensive analysis. Scientific review of evidence was apparent based on the literature review presented in the study. Results of homogeneity were not strong enough to determine generalizability of this study. However, the scope of the study included participants all adult aged, undergoing non-ocular surgery with general anesthesia, which comprises a large variety of patients.

		Segal et al., 2014 determined that 0.11% of patients developed a corneal abrasion based on significant risk factors. This study concluded that Trendelenburg position, urological surgery, same day admission, general anesthesia, prone position, eyes taped during surgery, estimated blood loss, main PACU recovery, oxygen use during transport, female gender, and Caucasian race contribute to higher rates of corneal injury. A treatment algorithm is presented in this study for post-anesthesia care unit nurses to initiate when a patient complains of a potential corneal epithelial injury. Vetter et al., 2012 learned that implementation of an ongoing educational program regarding documentation and eye protection during general anesthesia led to a decrease in the number of monthly corneal abrasions. Researchers reported that there were 1.20 corneal abrasions per 1,000 surgeries prior to the intervention and 0.09 per 1,000 surgeries post-intervention. Eye protection documentation was a mere 3.4% pre-intervention and 74.9% post-intervention. The facility presented that there was a cost-effective benefit of $637 for every corneal abrasion prevented. Throughout 45 months of follow-up the interventions showed a steady increase in improvement.	**B.** The study sample size was sufficient to provide statistically applicable results. The control group was randomly chosen using computer-based software. Patient identity was unidentified to strengthen the results of the statistical analysis. Heterogeneity of confounding variables provides generalizability of the study. Treatment recommendations were provided based on best evidence from literature review. The results of the study are statically significant to provide a guide to practice change. **A.** This study comprised a very large sample size and was instituted at a very large health-care facility. There was a substantial literature review prior to initiation of the quality improvement project. Although there was no randomization, the protocols were rigorous and very-well defined. The sample was proven homogenous, thus limiting the generalizability of the study. Statistical analysis was significant and led to clear recommendations for practice and implementation. Limitations were presented in the study. Findings of the study were corroborated with other large facilities such as The Mayo Clinic. The two studies analyzing anesthesia-led corneal abrasion treatment were both of sufficient sample size and quality to suggest practice change. The study by Lichter et al., 2015 had a very large sample size, yet lacked a control group or randomization unlike Segal et al., 2014 that had a much smaller sample size, but included randomization and blinding. Heterogeneity of confounding variables was present in the Segal et al., 2014 study leading to generalizability and relied on a strong literature review of best evidence for treatment recommendations. Lichter et al., 2015 did provide strong enough evidence to suggest practice change, yet this was an observational study that lacked prior statistics.

Figures

Figure 1

Everett Rogers' Diffusion of Innovation Theory

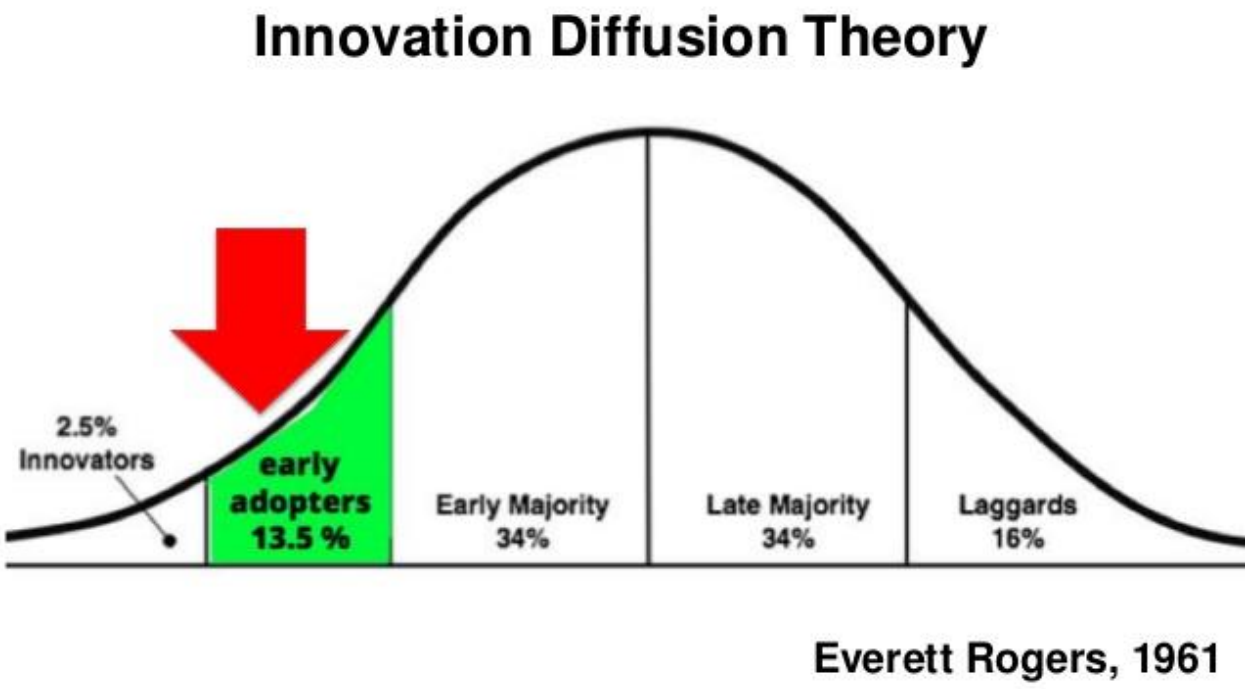
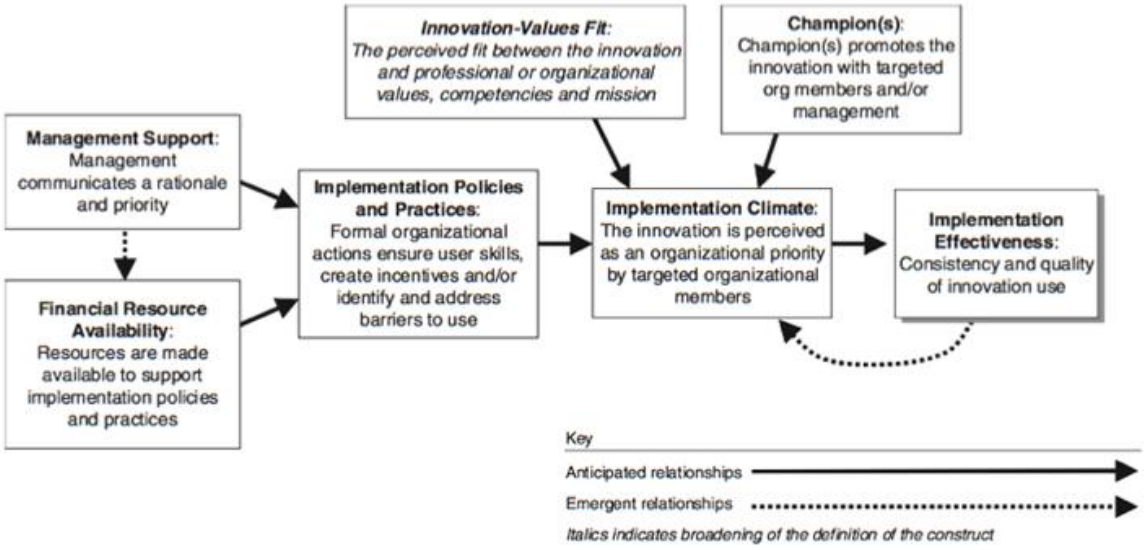
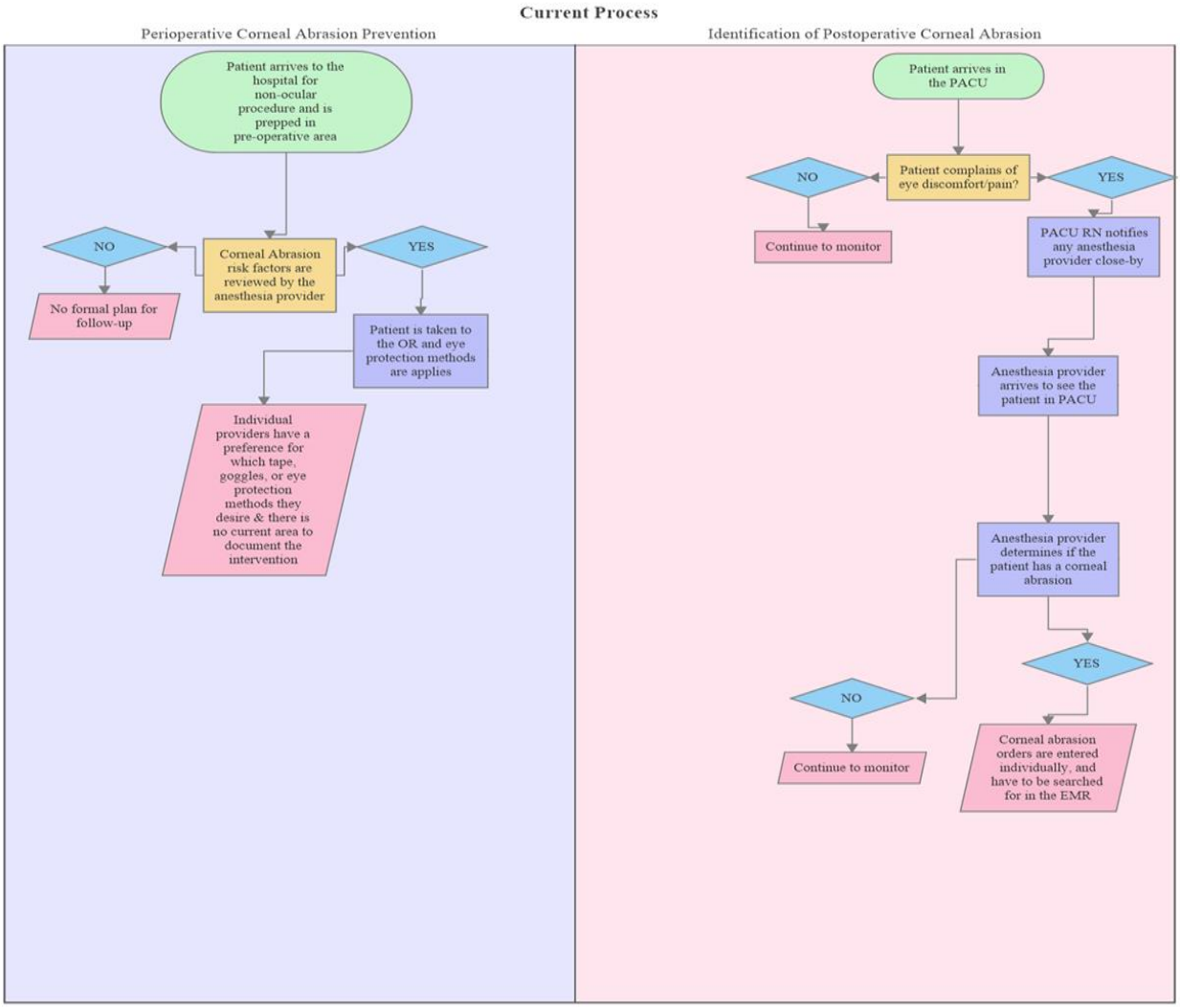


Figure 2
Helfrich's Complex Innovation Implementation Framework



Appendix A

Current Corneal Abrasion Workflow



Appendix B

Corneal Abrasion Prevention Protocol Checklist

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

Patient Position

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

Induction

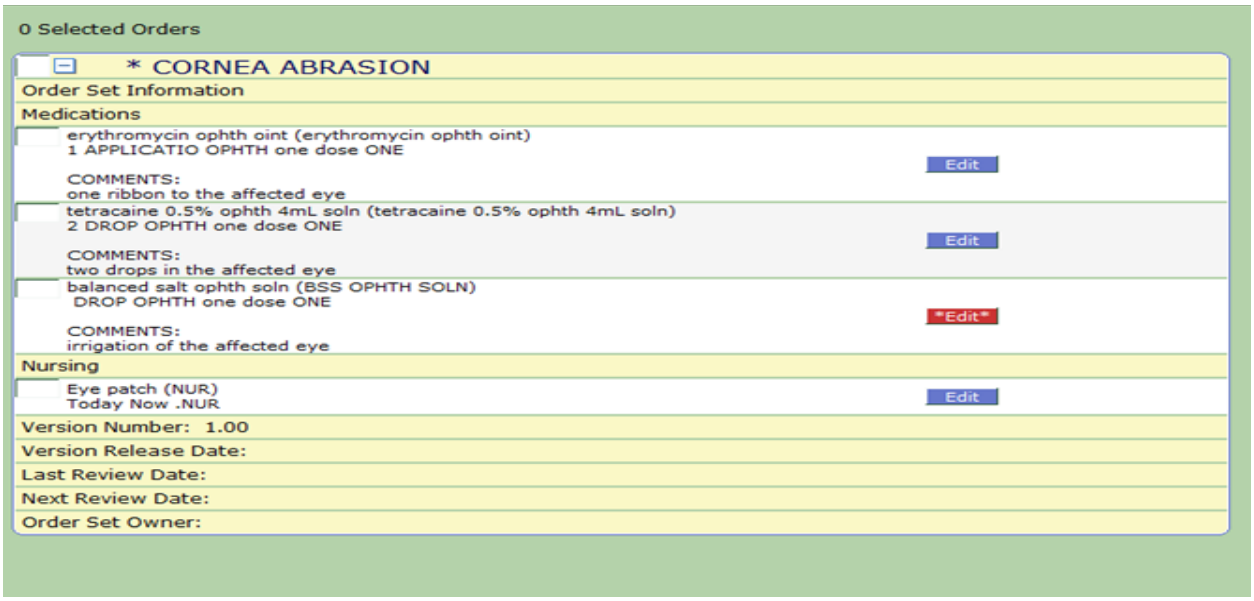
- ☐ Pulse oximeter- fourth finger of the non-dominant hand if appropriate
- ☐ Objects removed from provider's wrist/neck prior to induction
- ☐ Bio-occlusive ocular dressing applied to both eyes immediately after induction
  - ☐ Eyelids taped from upper eyelid towards lower eyelid
  - ☐ Eye lids are 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

Corneal Abrasion Order-set for Electronic Medical Record



Appendix D

Corneal Abrasion Documentation Auditing Workbook

Week	Dates	Position (Supine, Lateral, or Trendelenburg/Reverse Trendelenburg)	Eligible for intraoperative prevention protocol	Was the perioperative prevention checklist completed (on QA form)	Percent compliance of CA prevention documentation in respective positions
1	8/29-9/4	75	75	0	0
2	9/5-9/11	64	64	0	0
3	9/12-9/18	74	74	0	0
4	9/19-9/25	69	69	0	0
5	9/26-10/2	65	80	41	63
6	10/3-10/9	62	81	35	56
7	10/10-10/16	48	65	41	85
8	10/17-10/23	73	83	68	82
9	10/24-10/30	75	88	68	77
10	10/31-11/6	81	85	69	81
11	11/7-11/13	74	82	68	83
12	11/14-11/20	69	71	60	84
13	11/21-11/27	73	76	62	81
14	11/28-12/4	84	88	72	82
15	12/5-12/11	88	89	75	84