

CREATION AND IMPLEMENTATION OF AN INTRAOPERATIVE LIDOCAINE INFUSION PROTOCOL FOR GASTRIC SURGERY

by

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Abstract

Background: The recent opioid epidemic in the United States has damaged the country's public health system and led to devastating patient outcomes. Healthcare providers are responsible to do their part in reducing these negative consequences.

Purpose: This quality improvement project aimed to develop and implement an evidence-based protocol for an intraoperative lidocaine infusion during gastric surgery. Data was collected to evaluate whether this intervention correlated with reduced postoperative narcotic use and improved patient outcomes.

Methods: Baseline patient outcome data was collected through chart review on 25 patients of Dr. Verseman undergoing gastric surgery prior to protocol implementation. Subsequently, education was provided to the clinical associates of Kalamazoo Anesthesiology regarding the lidocaine protocol components and associated benefits. After implementation, provider adherence to the protocol was assessed, as well as patient outcomes for those who received all components of the lidocaine protocol.

Results: Complete provider adherence to the lidocaine protocol occurred in nine out of 76 opportunities. Overall, opioid administration was decreased in the lidocaine (protocol) group. Additionally, opioid administration was 78% lower in the lidocaine (protocol) group at 12-24 hours. Cumulative opioid administration over the first 24 hours postoperatively was 46% lower in the lidocaine (protocol) group.

Conclusion: Despite knowledge of current literature and the lidocaine protocol components, anesthesia providers had a low level of adherence to the protocol, overall. Patients who did receive all elements of the lidocaine protocol demonstrated decreased consumption of opioids in the postoperative period.

Key Words: lidocaine infusion, intraoperative, gastric surgery, narcotic

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CREATION AND IMPLEMENTATION OF AN INTRAOPERATIVE LIDOCAINE INFUSION PROTOCOL FOR GASTRIC SURGERY

Background and Significance

Introduction

In October 2017, the President of the United States declared the opioid epidemic to be a public health emergency due to its devastating effects on public health and socioeconomic welfare (Centers for Medicare & Medicaid Services, 2020). The United States accounts for 4.4% of the world's population yet consumes 80% of the world's supply of opioids (Stone et al., 2017). It is estimated that the opioid epidemic claims approximately 130 lives each day (National Institute on Drug Abuse, 2019). The Centers for Disease Control and Prevention has estimated the economic burden of prescription opioids to exceed \$78.5 billion each year (National Institute on Drug Abuse, 2019). Addressing this epidemic can only be accomplished through a concerted and cooperative effort between the government, the public, and healthcare providers across the country.

Healthcare providers are in a unique position to facilitate change and curtail this epidemic. They are the front-line work force providing care for those suffering the devastating physiologic consequences of opioid abuse. Since 1999, the amount of overdose deaths involving opioids, including those prescribed by healthcare professionals, has quadrupled (Centers for Medicare & Medicaid Services, 2020). Considering this startling statistic, healthcare providers are called to reevaluate their practice and determine if they are making the best decisions for their patients. The initiation of opioids for acute postoperative pain is a contributing factor in the development of persistent opioid use. One study demonstrated that the risk of opioid use at 90 days postoperative, in patients who were previously opioid naïve, may be as high as 6.5%

(Quinlan, 2019). Anesthesia providers must be willing to adopt new practices as evidence emerges that our intraoperative anesthetic can have a significant impact on postoperative opioid use and its associated consequences.

Administration of opioids in the perioperative period is associated with increased length of hospital stay, overall increased cost of care, and in-hospital complications including cardiac arrest (Casserly & Alexander, 2019). Postoperative nausea and vomiting (PONV) is an additional side effect of opioid administration, and a highly feared anesthetic complication for patients undergoing general anesthesia. Further adverse effects of opioids include constipation and postoperative paralytic ileus. Though they are effective at pain reduction, opioids have several potentially dangerous side-effects, particularly when administered in large doses.

Currently many institutions rely primarily on opioids for pain control during surgery and in the postoperative period. Multimodal therapy is a strategy which utilizes other non-opioid adjuncts to decrease the amount of opioids administered. Additionally, evidence has demonstrated that multi-modal therapy may be a more effective pain control approach, thereby reducing some of the physiological consequences of uncontrolled pain (Graff & Grosh, 2018). In light of the recent opioid epidemic, it is imperative for anesthesia providers to utilize a multimodal approach for pain control in order to minimize the use of perioperative opioids.

One potential non-opioid adjunct for pain control is an intraoperative lidocaine infusion. Pain transmission relies heavily on the proper functioning of sodium channels. Lidocaine is an amide local anesthetic that binds to voltage-gated sodium channels and decreases the rate of signal transmission through nociceptive afferent fibers (Kim, T. H. et al., 2013). By suppressing these specialized pain neurons, lidocaine suppresses the perception of pain after an acute injury, such as surgery. Additionally, lidocaine reduces pain by reducing the amount of surgery-induced

elevation of pro-inflammatory mediators. The following literature review aims to address this question: In adult patients undergoing gastric surgery, does an intraoperative lidocaine infusion compared to standard therapy impact postoperative pain control?

Literature Review

The aim of this literature review is to explore the impact of utilizing an intraoperative lidocaine infusion in patients undergoing general surgery. The primary outcome investigated was the impact on postoperative pain and opioid requirements. Secondary outcomes include PONV, return of gastric function, and length of PACU and hospital stays.

Methods

A systematic search of current literature was conducted, utilizing the following databases: CINAHL, the Cochrane Library, and PubMed. Key search terms included “intraoperative lidocaine infusion”, “postoperative pain”, and “recovery”. Criteria for inclusion consisted of peer-reviewed articles which specifically contained data comparing the impact on postoperative pain control between a lidocaine group and a placebo group. Articles were excluded which did not measure postoperative pain or opioid requirements. High-level articles were selected, excluding anything outside of a meta-analysis or randomized controlled trial (RCT). Articles published as far back as 2007 were included, to maximize the amount of data analyzed.

Results

The search of the medical databases yielded 176 results. After applying the inclusion and exclusion criteria outlined above, 33 studies remained. Ultimately, 16 articles were chosen, with the remaining 17 excluded based on relevancy. Of the 16 included studies, 11 are RCTs (Choi et al., 2012; De Oliveira et al., 2012; Grady et al., 2012; Herroeder et al., 2007; Kang et al. 2012; Khan et al., 2019; Kim, T. H. et al., 2013; Kim, K. et al., 2014; Lauwick et al., 2008; Soliman &

Gharbiya, 2015; Tikuisis et al., 2013) and five are meta-analyses (Kranke et al., 2015; McCarthy et al., 2010; Sun, Li, Wang et al., 2013; Vigneault et al., 2011; Weibel et al., 2018).

Literature Review

Postoperative Pain Control

Sixteen high-quality research articles were chosen for the purpose of this review, some which support the role of the intraoperative lidocaine infusion for improving postoperative pain control, and some which do not. A further examination of the study methods and population characteristics will illuminate a potential rationale for this discrepancy and guide the anesthesia provider in the best use of this therapy.

Opioid Usage. This review includes 10 RCTs which report data on postoperative opioid use (Choi et al., 2012; De Oliveira et al., 2012; Grady et al., 2012; Herroeder et al., 2007; Kang et al., 2012; Khan et al., 2019; Kim, T. H. et al., 2013; Kim, K. et al., 2014; Lauwick et al., 2008; Soliman & Gharbiya, 2015). Six of these 10 studies demonstrate a statistically significant reduction in opioid requirements for patients who were given an intraoperative lidocaine infusion versus a placebo infusion ($p < 0.05$) (De Oliveira et al., 2012; Grady et al., 2012; Kim, T. H. et al., 2013; Kim, K. et al., 2014; Lauwick et al., 2008; Soliman & Gharbiya, 2015). The six studies share important traits. First, each study required the lidocaine infusion to be run at a dose of 2 mg/kg/h. Second, all but one trial was conducted on patients undergoing abdominal surgery. These results suggest that lidocaine infusions are most efficacious when utilized for abdominal surgery at a rate of 2 mg/kg/h. Interestingly, the one study which was conducted on patients receiving lumbar surgery demonstrated slightly different results than the other analyses (Kim, K. et al., 2014). In this study, while overall postoperative opioid consumption was lower in the intervention group, opioid use leveled off between the control and intervention groups at 48

hours postoperatively. This information is perhaps suggestive of the higher severity and duration of pain associated with lumbar surgery versus abdominal surgery (Jaffe, 2006).

Four RCTs did not demonstrate reduced postoperative opioid use. (Choi et al., 2012; Herroeder et al., 2007; Kang et al., 2012; Khan et al., 2019). Two of these studies utilized a lower dose of lidocaine infusion- 1.5 mg/kg/h instead of the dose of 2 mg/kg/h which was used by the trials that showed significant decreases in postoperative opioid use (Kang et al., 2012; Choi et al., 2012). Additionally, two studies were conducted on patients undergoing breast surgery unlike the other studies which were focused primarily on abdominal surgeries (Choi et al., 2012; Khan et al., 2019). The 2007 RCT by Herroeder et al. was conducted on patients undergoing abdominal surgery, utilizing the lidocaine dosing of 2 mg/kg/h, but still did not see reduced opioid consumption postoperatively.

Five meta-analyses were included in this discussion which give further insight into the role of lidocaine in postoperative opioid use (Kranke et al., 2015; McCarthy et al., 2010; Sun et al., 2013; Vigneault et al., 2011; Weibel et al., 2018). Two analyses evaluated research specifically examining abdominal surgeries, both of which demonstrated reduced opioid requirements (Sun et al., 2013; Vigneault et al., 2011). Sun et al. (2013) reviewed 21 RCTs and revealed that at 48 hours, the weighted mean difference for cumulative analgesic opioid (in morphine equivalents) was -7.04 mg in the lidocaine group. Vigneault et al. (2011) reviewed 29 RCTs and found the difference to be -8.44 mg morphine. The three remaining meta-analyses did not focus specifically on abdominal surgery, but rather all procedures requiring general anesthesia (Kranke et al., 2015; McCarthy et al., 2010; Weibel et al., 2018). For each of these three meta-analyses, when all data was utilized for statistical analyses, no significant evidence was found to correlate lidocaine with reduced postoperative pain scores or opioid use. However,

two of the meta-analyses ran additional data utilizing only patients undergoing abdominal surgery (Kranke et al., 2015; McCarthy et al., 2010). When abdominal surgeries were isolated, significant reduction in both postoperative pain rating and opioid use were found (Kranke et al., 2015; McCarthy et al., 2010). Indeed, McCarthy et al. (2010) reported that when utilized for abdominal surgery, intraoperative lidocaine infusions reduced postoperative opioid consumption by up to 85% ($p < 0.001$) (2010). Weibel et al. (2018) did not run a separate analysis based on abdominal surgery, and thus did not support a relationship between lidocaine infusions and postoperative opioid use (2018) in abdominal surgery patients.

Patient Reports of Pain. An additional measure of pain control was patient-reported intensity of pain. All RCTs included in this review contain data on this outcome. Of these 11 RCTs, seven demonstrated reduced pain ratings in the postoperative period (De Oliveira et al., 2012; Grady et al., 2012; Herroeder et al., 2007; Kim, T. H. et al., 2013; Kim, K. et al., 2014; Soliman & Gharbiya, 2015; Tikuisis et al., 2013). Each of these seven RCTs were conducted on patients having abdominal surgery, and all intervention groups utilized a lidocaine infusion at the rate of 2 mg/kg/h.

Four RCTs did not demonstrate improved patient-reported intensity of pain in the intervention groups (Choi et al., 2012; Kang & Lee, 2012; Khan et al., 2019; Lauwick et al., 2008). Two of these studies infused lidocaine at the lower rate of 1.5 mg/kg/h (Choi et al., 2012; Kang et al., 2012). Additionally, two of the studies investigated the effect of intraoperative lidocaine during breast surgery (Choi et al., 2012; Khan et al., 2019). One study among this subset utilized the optimal dose of 2 mg/kg/h in patients undergoing abdominal surgery, and still did not demonstrate improved pain scores for the lidocaine group (Lauwick et al., 2008). It should be noted that although Lauwick et al. (2008) found similar pain scores among the control

and intervention group, the control group required significantly higher doses of fentanyl in the postoperative care unit to achieve those similar pain scores. Specifically, the control group received an average cumulative dose of 153.5 micrograms of fentanyl, while the lidocaine group received only 98.00 micrograms of fentanyl (Lauwick et al., 2008)

Inflammation and Pain. The role of lidocaine in augmenting pain may be partially attributed to its anti-inflammatory properties. An abundance of evidence in the literature has linked proinflammatory cytokines to the pathological process of pain. Cytokines work directly to activate nociceptive neurons. Additionally, cytokines are involved in inflammation-induced central sensitization, which can contribute to hyperalgesia (Zang & An, 2007). Two RCTs included in this review directly measured levels of proinflammatory cytokines at various intervals postoperatively (Herroeder et al., 2007; Kim, K. et al., 2014). Both revealed significantly lower levels of cytokines in the lidocaine group compared to the control group ($p < 0.05$).

Through close examination of individual RCTs, data emerges to guide clinicians toward appropriate, evidence-based practice. Inclusion of meta-analyses, the highest level of research evidence, further validates the trends detected in individual trials. In terms of pain control, a review of these sixteen studies supports the use of intraoperative lidocaine infusion for abdominal surgeries, administered at a dose of 2 mg/kg/h.

Secondary Outcomes

Postoperative Nausea and Vomiting. Eight RCTs in this review included data on the incidence of postoperative nausea and vomiting (Choi et al., 2012; De Oliveira et al., 2012; Khan et al., 2019; Kim, T. H. et al., 2013; Kim, K. et al., 2014; Lauwick et al., 2008; Soliman & Gharbiya, 2015; Tikuisis et al., 2013). All of these studies, with the exception of Choi et al.

(2012), demonstrated reduced PONV in the lidocaine group. Three studies demonstrated a statistically significant decrease in PONV incidence in patients that received an intraoperative lidocaine infusion ($p < 0.04$) (De Oliveira et al., 2012; Kim, T. H. et al., 2013; Soliman & Gharbiya, 2015). Four RCTs demonstrated a trend toward lower incidence of PONV among the lidocaine group, but failed to reach statistical significance (Khan et al., 2019; Kim, K. et al., 2014; Lauwick et al., 2008; Tikuisis et al., 2013). It should be noted that among the 11 RCTs included in this literature review, sample sizes were relatively low, with the maximum being 64 patients. Low sample sizes may be a barrier to achieving statistical significance in this instance.

A look into the meta-analyses included in this review confirms that larger sample sizes do, in fact, permit statistical significance in terms of this outcome. Each of the five meta-analyses concluded, with 95% confidence, that there was a lower incidence of PONV for patients who received lidocaine (Kranke et al., 2015; McCarthy et al., 2010; Sun et al., 2013; Vigneault et al., 2011; Weibel et al., 2018).

Return of Gastric Function. An additional proposed benefit of lidocaine is a faster return of gastric function, which could help reduce the incidence of a postoperative paralytic ileus. Lidocaine is thought to offer this benefit either indirectly through reduced opioid intake, or directly by its inherent pro-peristaltic properties (Eipe et al., 2016). Five RCTs in this review analyzed this outcome (Choi et al., 2012; Grady et al., 2012; Herroeder et al., 2007; Kang et al., 2012; Tikuisis et al., 2013). Three studies reported a faster return of flatus, by an average of time of 7.4 hours (Grady et al., 2012; Herroeder et al., 2007; Kang et al., 2012). Three studies revealed a faster time to defecation, by an average of 9.3 hours (Choi et al., 2012; Herroeder et al., 2007; Tikuisis et al., 2013). Only one study did not demonstrate a faster return of gastric function in the lidocaine group (Khan et al., 2019).

Length of Hospital Stay. Length of hospital stay is another outcome of interest for researchers. If the lidocaine intervention could be correlated with a reduced hospital stay, it could potentially play a role in reducing the total cost associated with surgery. Six RCTs examined this outcome (Choi et al., 2012; Herroeder et al., 2007; Kang et al., 2012; Kim, K. et al., 2014; Lauwick et al., 2008; Tikuisis et al., 2013). Four of these studies demonstrated a reduction in length of stay for the patients who received lidocaine, by an average of one day (Herroeder et al., 2007; Kang et al., 2012; Kim, K. et al., 2014; Tikuisis et al., 2013). The remaining two studies did not demonstrate a correlation between the lidocaine intervention and total length of hospital stay (Choi et al., 2012; Lauwick et al., 2008).

Patient Satisfaction. Four RCTs compared patient satisfaction scores between the control and intervention groups (Choi et al., 2012; De Oliveira et al., 2012; Grady et al., 2012; Soliman & Gharbiya, 2015). Three found significantly higher patient satisfaction in the lidocaine group (Kang et al., 2012; Kim, K. et al., 2014; Tikuisis et al., 2013).

Lidocaine Toxicity. An additional outcome of concern for clinicians is the risk of lidocaine toxicity which can be associated with systemic administration. Lidocaine plasma levels greater than 5 µg/mL increase the risk of central nervous stimulation, leading to drowsiness, tremor, and myocardial dysfunction (Herroeder et al., 2007). No study reported any adverse effects indicating lidocaine toxicity. Only one study measured postoperative plasma levels of lidocaine and found a mean level of 1.1-4.2 µg/mL, well within a range of safety (Herroeder et al., 2007).

Purpose Statement

The purpose of this quality improvement project was to develop and implement an evidence-based protocol for an intraoperative lidocaine infusion during gastric surgery.

The project consisted of five parts:

1. Development of an evidenced-based Intraoperative Lidocaine Infusion Protocol
2. Education of the anesthesia team
3. Collection of baseline data
4. Implementation of the Intraoperative Lidocaine Infusion Protocol
5. Evaluation of the results

Conceptual Framework

The Neuman Systems Model (Appendix C) is a grand theory which examines how nursing interventions influence patients' response to stressors. It is a wellness model that examines relationships between stress and feedback loops. Stressors can be intrapersonal or interpersonal and can lead to patient instability and illness. Through the Neuman Systems Model, anesthesia providers can aid in the patient's line of defense by utilizing preventative interventions for retention, attainment and maintenance of optimal patient wellness.

The Neuman Systems Model can be applied to patients undergoing gastric surgery. The surgical procedure is an intrapersonal stressor that causes the patient's normal line of defense to release inflammatory mediators that can lead to patient instability. The use of an intraoperative lidocaine infusion is a nursing intervention that supports the patient's line of resistance by acting as a protective mechanism that attempts to stabilize the patient's system and foster a return towards wellness. Optimizing the patient by the use of an intraoperative lidocaine infusion will help the patient maintain stability and integrity and prevent future stressors—namely, postoperative pain, nausea and vomiting.

Project Methodology

Sample and Setting

This quality improvement project was conducted at Ascension Borgess Hospital in Kalamazoo, Michigan with a sample size of 25 patients. There were no financial compensation or any conflicts of interest. The evidence-based protocol that was used is available in Appendix A.

Adults 18 years or older undergoing gastric surgery performed by Dr. Verseman, scheduled for two hours or longer, at Ascension Borgess Hospital were eligible for inclusion. Patients are included in the study regardless of preoperative medication administration, including any medications given as part of an Early Recovery After Surgery (ERAS) protocol. Exclusion criteria included an allergy to lidocaine, patients with unstable coronary disease, recent myocardial infarction (within the past 6 months), an ejection fraction of less than 20%, heart block, electrolyte disturbances of critical values, seizure disorders, severe hepatic impairment (defined as a bilirubin > 1.46 mg/dL), severe renal impairment (defined as glomerular filtration rate of < 15), and/or administration of a transverse abdominal plane (TAP) block.

Study Design and Implementation Plan

Development of Evidenced-Based Intraoperative Lidocaine Infusion Protocol

After extensive evaluation of the current evidence-based literature, the Intraoperative Lidocaine Infusion Protocol was created (Appendix A). A bolus dose of lidocaine helps achieve therapeutic levels and a dosage of 1.5mg/kg has been supported by the literature (Choi et al., 2012; De Oliveira et al., 2012; Greenwood et al., 2019; Herroeder et al., 2007; Kang et al., 2012; Kim, T. H. et al., 2013; Kim, K. et al., 2014; Lauwick et al., 2008; Soliman & Gharbiya, 2015; Tikuisis et al., 2013). Due to the evidence-based beneficial effects discussed in the literature review above, an infusion rate of 2 mg/kg/h was chosen. Greenwood et al. (2019) conducted a study in which plasma lidocaine levels were drawn at predetermined intervals on patients

receiving intravenous lidocaine infusions during major colorectal surgery. They found that heavier patients developed higher mean plasma lidocaine levels. Two patients reached plasma concentrations of greater than 10mcg/ml, putting these patients at high risk for Local Anesthetic Systemic Toxicity (LAST). For this reason, we chose to utilize actual body weight if a patient's Body Mass Index (BMI) $< 30\text{kg/m}^2$ and ideal body weight if a patient's BMI $\geq 30\text{kg/m}^2$. The context-sensitive half time is the time required for plasma concentration of a drug to decrease by 50% after a continuous infusion has been discontinued. The lidocaine infusion will be discontinued 20-40 minutes prior to extubation as it is the context-sensitive half-time of lidocaine.

Anesthesia providers were instructed to calculate weight-based dosing according to actual body weight for patients with a body mass index (BMI) $< 30\text{ kg/m}^2$, and according to ideal body weight for patients with a BMI $\geq 30\text{ kg/m}^2$. The anesthesia providers administered 1.5 mg/kg of lidocaine intravenously along with their choice of medications for anesthetic induction. Following intubation, the intraoperative lidocaine infusion was initiated at 2 mg/kg/h. The infusion was administered for the duration of the gastric procedure and was discontinued 20-40 minutes prior to anticipated extubation.

Education of the Anesthesia Team

Prior to initiation of the quality improvement project, an educational presentation was given to all anesthesia providers. This presentation occurred during a department monthly meeting. The anesthesia providers were provided a website link and asked to take the pre-education Lidocaine Infusion Test (Appendix B) created on Survey Monkey, which permitted determining base-line knowledge and areas for education. After the completion of the pre-test, a PowerPoint presentation was provided on the use of intravenous lidocaine infusions for gastric

surgery. The Intraoperative Lidocaine Infusion Protocol (Appendix A) was presented and explained to the anesthesia team. Time was allotted to answer questions. At the conclusion of the presentation, the anesthesia providers were provided an additional Survey Monkey website link to take a post-education Lidocaine Infusion Test (identical to the pre-test found in Appendix B), to assess if there was adequate education provided. In addition, all Kalamazoo Anesthesiology employees received an e-mail with the protocol (Appendix A) attached as well as the current supporting literature.

Collection of Baseline Data

Baseline data was collected on 25 patients prior to implementation of the Intraoperative Lidocaine Infusion Protocol for comparison of the measured outcomes. Dr. Verseman and/or his office team provided the medical record numbers of 25 patients who had gastric surgery without intraoperative lidocaine infusions, performed during the time period of January 1, 2017 to December 31, 2019. Medical record numbers were sealed and given to Kyle Nelson, Certified Registered Nurse Anesthetist for patient data protection. Chart review was performed immediately after obtaining the medical record numbers and was performed on campus, at Ascension Borgess Hospital. After the chart review was completed, the medical record numbers were destroyed via a locked confidential paper disposal system set in place by Ascension Borgess Hospital. Patient outcomes were measured and evaluated from the time the patient arrived in PACU. Patient outcome data were collected (see Appendix E).

Patient outcome data included:

- Assigned patient number
- Intraoperative medications given (narcotics in MME)
 - Fentanyl

- Morphine
- Dilaudid
- Number of antiemetics administered
- Intraoperative lidocaine infusion protocol used (yes/no)
- Time to first bowel sounds heard (hours after surgery)
- Time to first bowel movement (hours after surgery)
- PACU discharge time (hours after surgery)
- Hospital discharge time (hours after surgery)

Patient outcome data collected over specified time interval included:

- Pain score (0-10)
- Opioids administered (MME)
- Cumulative opioids administered (MME)
- Antiemetics administered (yes/no)
- Charted emesis (yes/no)

The above five outcomes were evaluated over the following post-operative time intervals

(time 0 indicates patients' arrival to PACU):

- 0 to <1 hour postoperatively
- 1 to < 4 hours postoperatively
- 4 to < 8 hours postoperatively
- 8 to < 12 hours postoperatively
- 12 to < 24 hours postoperatively

Implementation of the Intraoperative Lidocaine Infusion Protocol

Implementation of the Intraoperative Lidocaine Infusion Protocol began October 1, 2020. Prior to implementation, the anesthesia providers were presented with education about the protocol as well as the opportunity to address questions and concerns during a department meeting. After the conclusion of the education session, the Intraoperative Lidocaine Infusion Protocol was emailed to all anesthesia providers. Another e-mail was sent to all anesthesia providers one week before implementation of the protocol to remind them of the initiation date and the Intraoperative Lidocaine Infusion Protocol was attached. To further assist with ease of implementation, a copy of the Intraoperative Lidocaine Infusion Protocol (Appendix A) was placed on the anesthesia workstation. Our contact information was provided on the protocol to assist with availability if any questions occurred.

Anesthesia and Airway Management. Induction, maintenance and emergence of anesthesia was at the discretion of the anesthesia provider. Aside from the intraoperative lidocaine bolus and infusion, we did not attempt to control for any aspects of the anesthetic technique. Anesthesia providers were free to manage anesthesia and administer analgesics as they deemed appropriate for their patient.

Surgical Technique. All procedures were performed by Dr. Verseman and the surgical technique was at his discretion. We did not attempt to control for any aspect of the surgical technique or postoperative surgical management.

Potential Benefits

As stated in the literature review above, there are multiple benefits of lidocaine infusions. Intraoperative lidocaine infusions have the potential to decrease pain scores and opioid requirements. One of the reasons could be linked to lidocaine's anti-inflammatory properties. Lidocaine infusions are also associated with a decreased incidence of PONV. Patients who

receive an intraoperative lidocaine infusion have a quicker return of flatus and time to defecation. These findings protect against one of the potentially deadly complications of gastric surgery- postoperative paralytic ileus. Decreased pain scores, opioid consumption, and hospital length of stay can greatly improve patient satisfaction scores. These outcomes are weighed heavily in hospital reimbursement and can lead to an increase in revenue.

Potential Barriers

A few factors had the potential to limit the results of this project. While there was education provided and an Intraoperative Lidocaine Infusion Protocol (Appendix A), there was no way to ensure the anesthesia provider appropriately provided the lidocaine infusion until the chart review was completed. Next, we could not control for all variables throughout the patients' surgical experience, limiting the strength of the results. In addition, a specific sample size could not be guaranteed over the allotted time period which may have limited result findings and statistical significance. The Aldrete scoring system (Appendix D) is the most widely accepted and utilized recovery index for post-anesthesia care and readiness for transfer or discharge. Pitimana-aree et al. (2016) note that even though there is no gold-standard for a quality of recovery assessment tool, the Aldrete scoring system is reliable, although it has never been validated. It should be noted that the Aldrete scoring system is a qualitative assessment tool which could have led to differing interpretations by the PACU nurses, which ultimately could affect PACU discharge times.

Budget and Timetable

There were no anticipated financial needs or prospective costs involved in the implementation process. While there were no increased overhead costs from an anesthesia department perspective, there was a potential increased labor and material costs in the pharmacy

department. Increased pharmaceutical costs included the need for increased lidocaine infusions as well as the associated material and labor costs.

An anticipated timetable is shown in Appendix I.

Evaluation Plan

Evaluation of the Results

Intellectus Statistics (2021), a computerized statistical software, was utilized for data computation. Descriptive statistics, two-tailed independent samples t-test, and two-tailed Mann-Whitney two-sample rank-sum test were used to assess the pre-education and post-education Lidocaine Infusion Test (Appendix B) scores. Descriptive statistics including frequencies and percentage as well as summary statistics were utilized to assess the anesthesia provider's adherence to the Intraoperative Lidocaine Infusion Protocol (Appendix A). Two-tailed independent samples t-test was used to assess the outcomes outlined below. Comparisons between the two groups (pre-protocol and protocol used) included:

- Average pain scores at the time intervals listed
- Opioid requirements (in MME) at the time intervals listed as well as cumulative requirements
- Incidence of PONV (anti-emetics administered or charted emesis) at the time intervals listed
- Return of bowel sounds (in hours)
- Time of first bowel movement (in hours)
- PACU discharge time (in hours)
- Hospital discharge time (in hours)

Measurement Methods and Data Collection

After initiation of the Intraoperative Lidocaine Infusion Protocol, anesthesia providers communicated to the authors the date in which they performed the protocol. We then were able to access the surgery record for that date and accessed data for that patient. Kalamazoo Anesthesiology provided a Letter of Support (Appendix G) for these chart reviews. Data were collected after the patient had been discharged from the hospital via electronic medical chart review of Cerner. Protocol adherence data were collected adults 18 years or older undergoing gastric surgery with Dr. Verseman scheduled for two hours or longer, at Ascension Borgess Hospital from October 1, 2020 until January 31, 2021. Patients were included in the study regardless of preoperative medication administration, such as medications given as part of an Early Recovery After Surgery (ERAS) protocol. Exclusion criteria included an allergy to lidocaine, patients with unstable coronary disease, recent myocardial infarction (within the past 6 months), an ejection fraction of less than 20%, heart block, electrolyte disturbances of critical values, seizure disorders, severe hepatic impairment (defined as a bilirubin > 1.46 mg/dL), severe renal impairment (defined as glomerular filtration rate of < 15), administration of a transverse abdominal plane (TAP) block, and/or those who received an intraoperative lidocaine infusion.

Patient outcome data were collected only on the patients who received complete adherence to the protocol throughout the allotted evaluation period. The initial goal was to compare 25 pre-protocol patients to 25 patients who received complete adherence to the Intraoperative Lidocaine Infusion Protocol. After evaluation of 76 cases, only nine patients received complete adherence and therefore only the outcomes from those nine cases were compared to the 25 pre-protocol patients. Patient outcomes were measured and evaluated from the time the patient arrived in PACU.

Protocol adherence data included:

- Assigned patient number
- Lidocaine bolus was given with induction per the protocol (yes/no)
- Lidocaine infusion was initiated at the proper rate per the protocol (yes/no)
- Lidocaine infusion was discontinued at the proper time per the protocol (yes/no)
- Complete adherence to the protocol (yes/no)

Patient outcome data included:

- Assigned patient number
- Intraoperative lidocaine infusion protocol used (yes/no)
- Intraoperative medications given (narcotics in MME)
 - Fentanyl
 - Morphine
 - Dilaudid
 - Number of antiemetics administered
- Time to first bowel sounds heard (hours after surgery)
- Time to first bowel movement (hours after surgery)
- PACU discharge time (hours after surgery)
- Hospital discharge time (hours after surgery)

Patient outcome data collected over specified time interval included:

- Pain score (0-10)
- Opioids administered (MME)
- Cumulative opioids administered (MME)
- Antiemetics administered (yes/no)

- Charted emesis (yes/no)

The above five outcomes were evaluated over the following post-operative time intervals (time 0 indicates patients' arrival to PACU):

- 0 to <1 hour postoperatively
- 1 to < 4 hours postoperatively
- 4 to < 8 hours postoperatively
- 8 to < 12 hours postoperatively
- 12 to < 24 hours postoperatively

Baseline comparative data were collected in the same manner and on the same variables as listed above. In addition to the exclusion criteria above, any patients who received an intraoperative lidocaine infusion were also excluded from the baseline sample.

Evaluation Plan

For data management, Intellectus Statistics (2021) was utilized as a centralized repository for ease of computation of data sets. After data collection was completed, descriptive statistics and two-tailed independent samples t-tests were conducted on all major study variables as described above. Intellectus Statistics (2021), a computerized statistical software, was utilized and consulted for statistical analyses. All statistical computations were performed by the Intellectus Statistics software. A glossary of statistical definitions is placed in Appendix H.

Dissemination of the findings occurred after all cases were evaluated at another anesthesia department meeting as well as to Dr. Verseman and surgical teams as appropriate. A poster presentation was created and submitted to the American Association of Nurse Anesthetists for potential presentation at the 2021 Congress, as well as the Michigan Association of Nurse Anesthetists for potential presentation at the Fall 2021 conference.

Results

Education

The Kalamazoo Anesthesiology staff was asked to take the Lidocaine Infusion Test prior to the education provided on lidocaine and then an additional (and identical) test after the education was provided. The average pre-education test score was 62.08% while the average post-education test score was 84% ($p < .001$). These results indicate that the education provided was successful in improving and expanding on the anesthesia provider's knowledge about lidocaine.

Adherence

Anesthesia provider adherence to the Intraoperative Lidocaine Infusion Protocol was assessed from October 1, 2020 to January 31, 2021. Throughout this time period, 76 patients were eligible to receive the protocol, and were evaluated for adherence to the protocol. The Intraoperative Lidocaine Infusion Protocol had three components: a bolus dose, an infusion rate, and an infusion discontinuation time. Adherence to the protocol components as well as the protocol in its entirety was evaluated on a yes/no basis.

Overall

Most frequently, no components of the Intraoperative Lidocaine Infusion Protocol were followed correctly- which occurred in 34 out of 76 cases. In 25 cases, one component of the protocol was adhered to. In eight cases two components of the protocol were implemented correctly. Complete adherence to the Intraoperative Lidocaine Infusion Protocol occurred in only nine out of 76 opportunities. Frequencies and percentages are presented in Table 1.

Table 1

Frequency Table for the Number of Protocol Components Implemented Correctly

Variable	<i>n</i>	%
Percent of the Intraoperative Lidocaine Infusion Protocol followed (% as a decimal)		
0	34	44.74
0.33	25	32.89
0.66	8	10.53
1	9	11.84
Missing	0	0.00

Note. Due to rounding errors, percentages may not equal 100%.

Protocol Components

Bolus Dose. The Intraoperative Lidocaine Infusion Protocol instructed the anesthesia provider to give a 1.5mg/kg bolus dose of lidocaine with their choice of induction. Thirty percent of patients received the correct loading dose. The lidocaine bolus dose administered ranged from 0.38 to 3.33mg/kg.

Infusion Rate. The Intraoperative Lidocaine Infusion Protocol instructed anesthesia providers to initiate a lidocaine infusion at a rate of 2 mg/kg/h. The correct lidocaine infusion rate occurred in 34% of the patients ($n = 26$). The infusion rate was found to range from 0 to 3.16 mg/kg/h.

Discontinuation Time. The Intraoperative Lidocaine Infusion Protocol instructed anesthesia providers to discontinue the lidocaine infusion 20-40 minutes prior to expected extubation. The lidocaine infusion was discontinued appropriately in 22% of cases. The average discontinuation time was approximately five minutes prior to extubation. The discontinuation time ranged from 33 minutes prior to extubation, to 19 minutes after extubation.

Table 2 further divides the data into the three components of the Intraoperative Lidocaine Infusion Protocol and evaluates each component's adherence, as well as complete adherence to the protocol.

Table 2

Frequency Table for the Intraoperative Lidocaine Infusion Protocol Component Adherence

Variable	<i>n</i>	%
Lidocaine bolus given with induction per the protocol		
No	53	69.74
Yes	23	30.26
Missing	0	0.00
Initiated lidocaine infusion at the proper rate per the protocol		
No	50	65.79
Yes	26	34.21
Missing	0	0.00
Discontinued lidocaine infusion at the proper time per the protocol		
No	59	77.63
Yes	17	22.37
Missing	0	0.00
Complete adherence to the protocol		
No	67	88.16
Yes	9	11.84
Missing	0	0.00

Note. Due to rounding errors, percentages may not equal 100%.

Outcomes

Outcomes were compared between 25 patients who underwent gastric surgery prior to the implementation of the Intraoperative Lidocaine Infusion Protocol and the nine patients who underwent gastric surgery and received 100% adherence to the Intraoperative Lidocaine Infusion Protocol. Pain scores were rated on a scale of 0-10. Opioid administration was compared

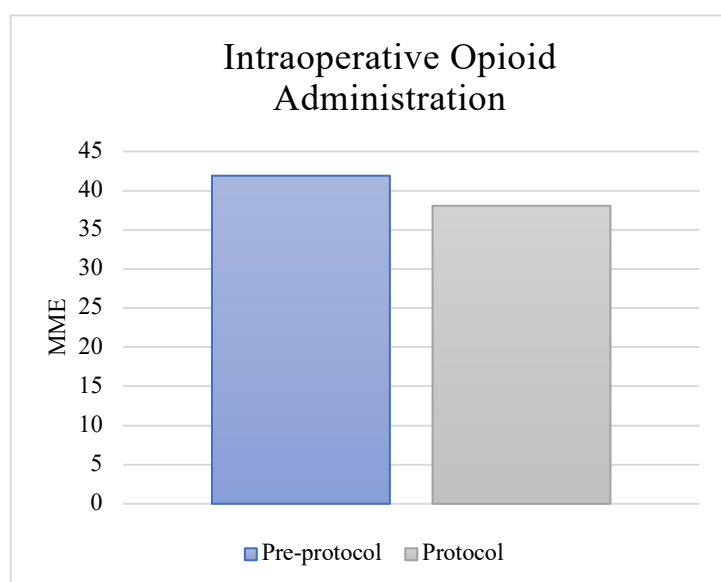
utilizing morphine milligram equivalents (MME). These outcomes were assessed 0 to < 1 hour, 1 to < 4 hours, 4 to < 8 hours, 8 to < 12 hours, and 12 to < 24 hours postoperatively, as well as cumulatively at these intervals. The time until the first bowel sounds were heard, PACU discharge time and hospital discharge time were measured in hours postoperatively.

Intraoperatively

Opioids. The amount of opioids administered intraoperatively was lower in the patients who received the Intraoperative Lidocaine Infusion Protocol ($M = 38.06$; $SD = 26.61$) compared to the patients pre-protocol ($M = 41.9$; $SD = 18.49$), however, it did not reach significance based on an alpha value of 0.05, $p = .638$. A bar plot of the means is presented in Figure 1.

Figure 1

The Mean Intraoperative Opioid Administration by Levels of the Intraoperative Lidocaine Infusion Protocol



Note. MME= morphine milligram equivalents

Antiemetics. The number of antiemetics administered intraoperatively was similar between the patients in the pre-protocol group ($M = 1.72$; $SD = 0.46$) and those who received the Intraoperative Lidocaine Infusion Protocol ($M = 1.89$; $SD = 0.33$), and therefore was not statistically significant ($p = .320$).

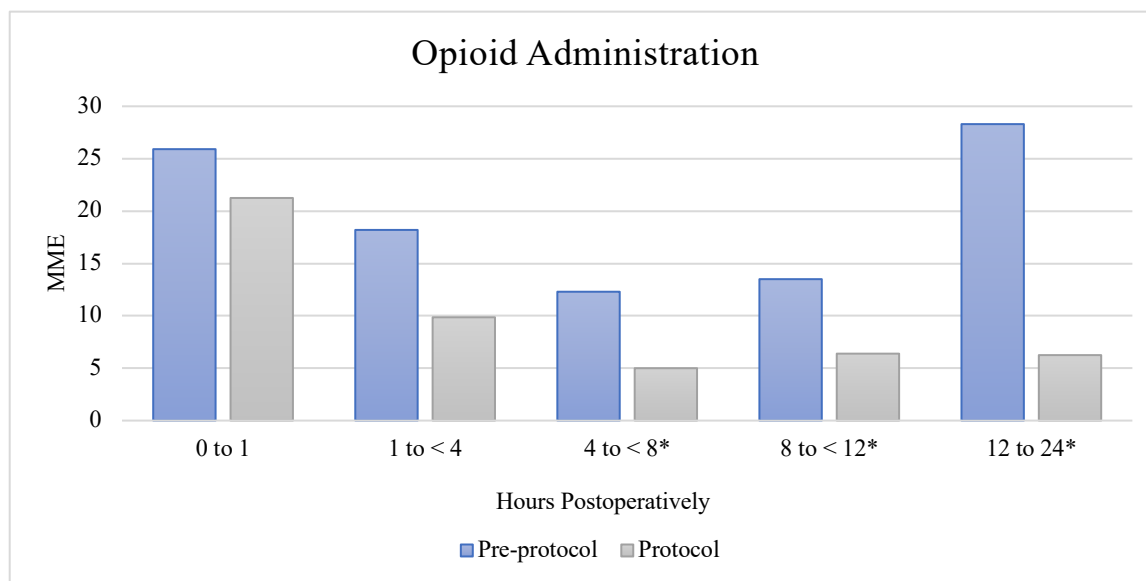
Postoperatively

Pain Scores. Pain scores between the pre-protocol and the protocol groups were similar throughout all time intervals assessed, and therefore were not statistically significant ($p > .05$).

Opioid Administration. Opioid administration in the protocol group was consistently lower than the pre-protocol group, however, it was not significant for the time intervals of 0-1 or 1-4 hours postoperatively ($p > .05$). From 4-8 hours postoperatively, the pre-protocol group had a mean opioid administration of 12.3 MME while the protocol group had a mean of 5.00 MME ($p = .044$). Opioid administration was also statistically significant during the 8-12 hours postoperative interval, in which the pre-protocol group had an average of 13.50 MME and the protocol group had an average of 6.39 MME. During this time period, the protocol group received less than 1/3 the amount of opioids compared to the pre-protocol group ($p = .049$). The opioid administration during the 12-24 hour postoperative time period was 78% lower in the protocol group. The pre-protocol group received an average of 28.3 MME while the protocol group received an average of 6.25 MME ($p < .001$). A bar plot of the means is presented in Figure 2.

Figure 2

The Mean Postoperative Opioid Administration Over Multiple Time Periods by Levels of the Intraoperative Lidocaine Infusion Protocol



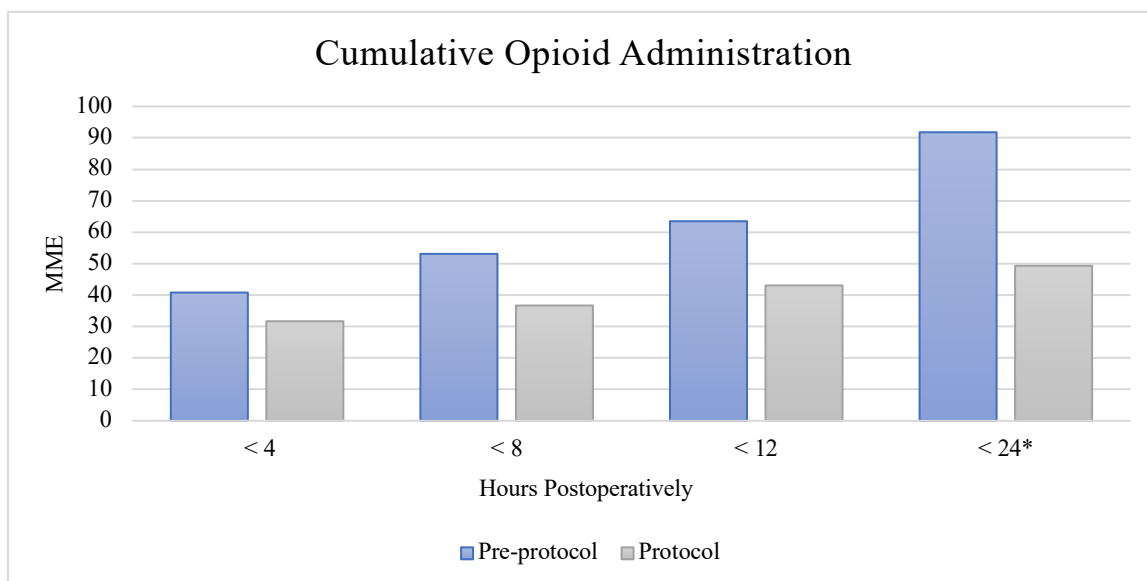
Note. MME= morphine milligram equivalents

* $p < .05$

Cumulative Opioid Administration. The cumulative opioid administration was consistently lower in the protocol group; however, it was not statistically significant for the time intervals of up to 1 hour, 4 hours, 8 hours, and 12 hours postoperatively ($p > .05$). The average cumulative opioids administered through 24 hours postoperatively was found to be significantly lower between the pre-protocol ($M = 91.8$; $SD = 39.68$) and the protocol ($M = 49.31$; $SD = 27.11$) groups ($p = .006$). The Intraoperative Lidocaine Infusion Protocol ultimately led to a 46% decrease in the average amount of opioids given in the first 24 hours postoperatively. A bar plot of the means is presented in Figure 3.

Figure 3

The Mean Postoperative Cumulative Opioid Administration Over Multiple Time Periods by Levels of the Intraoperative Lidocaine Infusion Protocol



Note. MME= morphine milligram equivalents

* $p < .05$.

Postoperative Nausea and Vomiting. There was no significant difference ($p > .05$) in the incidence of postoperative nausea and vomiting, or in antiemetics administered throughout any of the assessed time intervals.

Bowel Sounds. There was no significant difference ($p > .05$) in the time to the first bowel sounds heard. The results are presented in Table 3.

Table 3

Two-Tailed Independent Samples t-Test for the First Bowel Sounds Heard Postoperatively by the Intraoperative Lidocaine Infusion Protocol

Variable	Pre-protocol		Protocol		<i>t</i>	<i>p</i>	<i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
First bowel sounds heard postoperatively (hours)	12.13	8.27	13.25	7.30	-0.34	.737	0.14

Note. N = 31. Degrees of Freedom for the *t*-statistic = 29. *d* represents Cohen's *d*.

Bowel Movement. There were not enough data available to run statistics on this parameter.

PACU Discharge. A significant difference was found in the average time to PACU discharge, measured in hours postoperatively. The pre-protocol group experienced a shorter PACU stay ($M = 3.31$; $SD = 1.88$) compared to the protocol group ($M = 5.01$; $SD = 2.47$) ($p = .040$).

Hospital Discharge. On average, the protocol group was discharged from the hospital approximately 13 hours sooner than the pre-protocol group ($p = .018$). The results are presented in Table 4.

Table 4

Two-Tailed Independent Samples t-Test for the Hospital Discharge Time Postoperatively by the Intraoperative Lidocaine Infusion Protocol

Variable	Pre-protocol		Protocol		<i>t</i>	<i>p</i>	<i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Hospital discharge time postoperatively (hours)	46.40	12.62	33.11	16.36	2.50	.018	0.91

Note. N = 34. Degrees of Freedom for the *t*-statistic = 32. *d* represents Cohen's *d*.

Discussion

In recent years, the United States opioid epidemic has led to unnecessary death and economic burden on our healthcare system. Healthcare providers have been called to evaluate their practice and make necessary changes to address the staggering amount of prescription opioids being abused throughout the country. This quality improvement project focused on the role of the anesthesia provider in reducing perioperative opioid use and improving patient outcomes. Aims of this project included development and implementation of an intraoperative lidocaine infusion protocol, as well as evaluation of patient outcomes before and after protocol implementation.

Development and Implementation

A protocol was developed based on evidence from 11 RCTs and five meta-analyses. Implementation of this protocol began with education of anesthesia providers with a PowerPoint presentation illustrating research findings from the literature review as well as the proposed protocol. Post-education test scores (84%) were significantly higher than pre-education scores (62.08%), indicating that the education provided successfully expanded upon the anesthesia providers' knowledge about lidocaine.

Despite an effective educational intervention, many providers failed to adhere to the lidocaine protocol in practice. In the post-implementation data collection period, the protocol was adhered to only 11.84% of the time (Table 2). The protocol component most often missed was discontinuation of the lidocaine infusion at the proper time, which was accurately followed in just 22.37% of cases. In the clinical trials which guided the development of the lidocaine protocol, anesthesia providers adhered strictly to protocols outlined by researchers, lest subject

data be disqualified from the study. In contrast, this quality improvement project was limited in its ability to influence the care decisions made by independent anesthesia providers. Although providers were aware of the protocol requirements, barriers existed which prevented them from fully adhering to its components.

Based on our low level of provider adherence, it appears that education alone is not sufficient to consistently influence the practice habits of anesthesia providers. A 1996 study by Cohen et al. looked specifically at methods to effectively influence anesthesiologist practice habits regarding PONV prevention measures. This study demonstrated that education of the anesthesiologist did not improve patient outcomes by itself. It was not until individual provider feedback was implemented that the preventative measures translated into improved patient outcomes (Cohen et al., 1996). Thirty years ago it was suggested that the behavior of clinicians may be influenced in six ways: education, feedback, financial rewards, financial penalties, administrative changes, and clinician participation (Eisenberg & Williams, 1981). As graduate students implementing a quality improvement project, several of these strategies were unavailable to be utilized. Additionally, seasoned nurse anesthetists may rely more heavily on their clinical experience rather than guidelines and protocols, no matter how compelling the most recent research may be.

Several ways to improve adherence are discussed in the following section of Recommendations.

Patient Outcomes

Opioid Usage

Outcomes were compared between 25 patients who underwent gastric surgery prior to protocol implementation, and nine patients who received the intraoperative lidocaine with

complete protocol adherence. For all time periods observed, cumulative postoperative opioid consumption was lower in the lidocaine (protocol) group than the pre-protocol group. These results are consistent with several studies included in the preceding literature review (De Oliveira et al., 2012; Grady et al., 2012; Kim, T. H. et al., 2013; Kim, K. et al., 2014; Lauwick et al., 2008; Soliman & Gharbiya, 2015). It should be noted for the time periods of 0-1 hours and 1-4 hours, opioid consumption was decreased in the protocol group, however not to a level of statistical significance ($p > .05$). The discrepancy in opioid consumption between the two groups increased with time from surgery. This data is demonstrated visually in Figure 2. At 12-24 hours, opioid administration was 78% lower in the protocol group.

Overall, our findings suggest that intraoperative lidocaine, when implemented in accordance with the literature, may be associated with a reduction in postoperative opioid consumption. A higher level of protocol compliance may have allowed for more statistically compelling data.

Secondary Outcomes

Patients in the lidocaine (protocol) group required a significantly shorter hospital length of stay (LOS). The lidocaine (protocol) group was discharged from the hospital an average of 13 hours earlier than those who did not receive lidocaine. This finding is also represented in several studies (Herroeder et al., 2007; Kang et al., 2012; Kim, K. et al., 2014; Tikuisis et al., 2013). These studies demonstrated an even shorter reduction in LOS, by an average of one day. Inpatient hospital care accounts for nearly one-third of all health care spending in the United States (Weiss & Elixhauser, 2014). Data findings from this project still indicate that lidocaine infusions could play a role in reducing overall healthcare costs by reducing hospital LOS.

Although the patients who received the intraoperative lidocaine experienced a shorter overall hospital stay, they did not have a shorter PACU stay as anticipated. Patients in the lidocaine (protocol) group stayed in PACU for an average of 1.7 hours longer than the pre-protocol group ($p = 0.40$). Many factors contribute to the timeliness of PACU discharge including physician availability as well as the availability of beds in the inpatient unit. A more accurate assessment of patient readiness for discharge could be accomplished with frequent assessment and charting of patient Aldrete score (Appendix D). This would require an educational intervention involving the PACU nursing department.

Outcomes that demonstrated no statistically significant findings include antiemetic use, pain scores, time to first bowel sounds heard, and time to first bowel movement. The inability to generate statistically significant data regarding postoperative nausea and vomiting may have been related to the low number of subjects included in the dataset. The preceding literature review revealed that studies with larger datasets provided more compelling evidence for this outcome. Of the eight RCTs which analyzed PONV, only three of them could provide statistically significant evidence of reduced PONV in the lidocaine group (De Oliveira et al., 2012; Kim, T. H. et al., 2013; Soliman & Gharbiya, 2015). In contrast, all five of the meta-analyses provided statistically significant evidence of reduced PONV in the lidocaine group (Kranke et al., 2015; McCarthy et al., 2010; Sun et al., 2013; Vigneault et al., 2011; Weibel et al., 2018).

Thorough and accurate assessment of return of bowel function may have been limited by data collection methods as well as the function and format of the electronic medical record. In the studies which measured these outcomes, specific measures were taken to ensure that all pertinent data was collected. For example, in the study by Grady et al., patients were specifically

instructed to notify personnel if and when they experienced flatus (2012). Without implementing such instructions for each measure, it would be unlikely to collect complete and accurate data set regarding time to first bowel sounds and time to first bowel movement. Additionally, pain scores were unable to be compared between groups, as the majority of the pain assessments were not reported within the charting system.

Recommendations and Limitations

Recommendations

Recommendations for future quality improvement projects will include strategies to improve anesthesia provider adherence to the evidence-based protocol. It has been suggested that to most effectively influence the behavior of clinicians, the most respected staff should be involved as champions of the intervention (Rello et al., 2002). Future projects may explore ways to increase anesthesia staff engagement in the earlier stages of the project. This may include identifying areas of interest or need, review of the literature, and implementation of staff education. This, in turn, could improve staff engagement and willingness to more closely adhere to the proposed protocol.

In addition to increasing staff engagement in the project, future projects must also strive to remove all barriers that may prevent providers from adhering to the components of an evidence-based protocol. For example, embedding the lidocaine protocol into the charting system would ensure that the provider had instant access to all components throughout the care period. Additionally, the protocol required providers to perform a brief calculation to determine the weight-based infusion rate based on the patient's ideal body weight. This step could be circumvented by pre-programming infusion pumps with software that would perform the calculation on its own. As of this date, the pharmacy department at Bronson Methodist Hospital,

which shares anesthesia providers with Ascension Borgess Hospital, is working on making this improvement.

This project focused specifically on the benefits of lidocaine infusions for patients undergoing gastric surgery. In the future, projects may choose to explore the efficacy of this intervention in a variety of surgeries. This could serve further reduce the use of postoperative opioids on a widespread scale, and thereby reduce the individual and systemic associated consequences.

Limitations

Provider education was limited to a virtual, web-based presentation by federal gathering restrictions related to the current global pandemic. Post-implementation patient outcome data is limited by a small sample size, related to poor provider adherence to the evidence-based lidocaine protocol. In addition, the Corona Virus 2019 Pandemic may have altered how patients are cared for across multiple disciplines, including how patients are extubated by the anesthesia providers in the operating room or when patients are eligible to be transferred to the inpatient hospital unit. Potential causes and recommendations are discussed in the preceding sections.

Implications for Nursing Practice

While intraoperative lidocaine infusions have many direct implications for nursing practice, the overall implementation of this DNP project will affect the practice of nursing, and the goals of nursing in a variety of ways.

A fundamental goal in the practice of nursing is to improve patients' overall healthcare experience. Evidence collected from this DNP project suggests that administration of an intraoperative lidocaine infusion can improve postoperative pain and reduce postoperative opioid consumption while maintaining patient satisfaction. With reduced post-op pain and opioid

consumption, patients will additionally benefit from a reduction of side effects, such as nausea and vomiting. Faster return of gastric function and a reduction in hospital length of stay can also contribute to an enhanced patient experience.

In response to the opioid epidemic, insurance companies have implemented reimbursement protocols to reward initiatives that decrease opioid consumption, leading to a potential revenue sources for health systems. Reimbursement is also connected to patient satisfaction. Since evidence indicates that intraoperative lidocaine infusions reduce opioid consumption while maintaining or improving patient satisfaction, these infusions prove to be beneficial for both the patient and hospital reimbursement. In addition to the potential cost savings and revenue sources for health systems stated above, patients may see the greatest cost savings of all. The cost savings for patients would directly correlate to quicker PACU recovery times and decreased length of stay. While the exact cost savings would vary patient to patient depending on each health system, services provided, and insurance companies, any reduction in length of stay in a health system reduces the associated costs for the patient.

While the use of intraoperative lidocaine infusions could provide a tool for decreasing opioid use, nausea and vomiting and PACU discharge times in patients undergoing gastric surgery, dissemination of the benefits of intraoperative lidocaine infusions and study findings will contribute to an overall increase in the knowledge of nursing practice and will help improve patient outcomes. The findings from this study could then be expanded and applied to similar procedures such as laparoscopic abdominal surgeries and neurovascular spinal surgeries. The template outlined above for integration into practice could be easily recreated to work with other infusions or medications aimed at improving the health of patients. The profession of nursing has a duty to advocate for the health of patients and communities, and nursing interventions that are

safe, evidence-based, fiscally responsible, and improve patient outcomes should be adopted by the nursing profession.

Contributions to the Doctor of Nursing Practice Essentials

In 2006, the American Association of Colleges of Nurses (AACN) developed competencies that all Doctor of Nursing Practice (DNP) programs must address in the education of their students prior to graduation. The AACN refer to these competencies as the essentials of doctoral education for advanced nursing practice. There are eight overarching essentials in total that cover all the competencies required in order for graduate nursing students to address the increasingly complex needs of a modern healthcare system. In the development of this DNP project, these researchers have met many of the DNP essentials. More specifically this quality improvement projects meets DNP Program Essentials I, III and VIII.

Essential I: Scientific Underpinnings for Practice, is met by incorporating a nursing theory into the project to enhance healthcare delivery and improve patient outcomes. As discussed above, The Neuman Systems Model was utilized in this project to help guide the nursing interventions used throughout the DNP project.

Essential III: Clinical Scholarship and Analytical Methods for Evidence-Based Practice, is achieved by facilitating meaningful, evidence-based initiatives into the healthcare environment to promote better patient care and outcomes. A main purpose of this project was to implement meaningful change using current best evidence and practice guidelines regarding intraoperative lidocaine infusions to improve the care of patients—essentially the definition of Essential III.

Essential VIII: Advanced Nursing Practice, is met by working alongside multiple healthcare groups to facilitate a large systematic change to improve patient outcomes. Discussions and collaborations with pharmacy staff, anesthesia providers, and recovery nurses in the development

of the infusion protocol, feasibility of the project, and identification of barriers for implementation exemplify Essential VIII.

Conclusion

This quality improvement project aimed to reduce the impact of the downstream consequences of the national opioid epidemic by changing practice patterns of anesthesia providers. The effort encompassed multiple phases including review of the current literature, development and implementation of an evidence-based protocol, evaluation of provider adherence to the protocol, and evaluation of patient outcomes. Current literature indicates that intraoperative infusion of lidocaine is associated with decreased opioid administration in the postoperative period. Therefore, a protocol was developed to guide anesthesia providers in the administration of intraoperative lidocaine during gastric surgery. The evidence-based protocol was presented to the clinical associates of Kalamazoo Anesthesiology in the format of an educational, web-based staff meeting. Pre- and post-educational test stores indicated effective delivery of material related to the lidocaine protocol. Although many providers failed to adhere completely to the lidocaine protocol, patient outcomes still demonstrated reduced opioid consumption after implementation of the intervention. In future quality improvement projects, barriers to protocol adherence should be addressed to strengthen the quality of post-intervention data.

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Appendix A

Intraoperative Lidocaine Infusion Protocol

Intraoperative Lidocaine Infusion for Gastric Surgery

Study: The Oakland University SRNAs are implementing a protocol derived from evidence-based literature in which lidocaine will be run intravenously during gastric surgeries.

Rationale: Intravenous lidocaine infusions provide analgesia, anti-hyperalgesia and anti-inflammatory properties

Population: Adults 18 years or older undergoing gastric surgery performed by Dr. Verseman scheduled for two hours or longer, at Ascension Borgess Hospital

Exclusion Criteria:

- Allergy to lidocaine
- Unstable coronary disease
- Recent myocardial infarction (within the past 6 months)
- Ejection fraction <20%
- Heart block
- Electrolyte disturbances with critical values
- Seizure disorders
- Severe hepatic impairment (bilirubin >1.46mg/dL)
- Severe renal impairment (Glomerular Filtration Rate<15)
- Administration of a Transverse Abdominal Plane (TAP) block

Ideal Body Weight Calculation:

Males: Height (cm) – 100

Females: Height (cm) – 105

Instructions:

- For all lidocaine weight-based dosing:
 - If BMI <30kg/m²: use *actual body weight*
 - If BMI ≥30kg/m²: use *ideal body weight*
- Proceed with anesthetic induction of choice with the inclusion of lidocaine 1.5 mg/kg, IV push
- Start lidocaine infusion at 2mg/kg/h
- Provide anesthesia and analgesia as deemed appropriate
- Discontinue lidocaine infusion 20-40 minutes prior to extubation

Infusion Rate Calculation:

$$\text{Mg/min} = \frac{2 \times \text{kg}}{60}$$

If you have any questions, please feel free to contact us via email, text, or TigerText.

Sincerely,

Kayla Donnay
kdonnay@oakland.edu
(906)869-9966

Eric Howard
erichoward@oakland.edu
(231)736-4977

Lindsey Krueger
lindseykrueger@oakland.edu
(847)987-8891

Treatment for Local Anesthetic Systemic Toxicity (LAST)

1. Stop infusion
2. Call for help
3. Administer 100% FiO₂
4. Assess airway, breathing, and circulation- prevent hypoxia and acidosis
5. Give a benzodiazepine to treat and/or prevent seizures
 - a. Caution with propofol as it can further depress cardiac function
 - b. If ineffective, give a small dose of succinylcholine or a nondepolarizing neuromuscular blocking drug, which will stop muscle contraction. This will decrease the oxygen consumption, hypoxemia, and acidosis but will NOT stop the seizure activity in the brain
6. If cardiac arrest occurs, initiate ACLS with modifications:
 - a. Small doses of epinephrine: 10-100mcg (<1mcg/kg) boluses
 - i. NOTE: epinephrine can hinder resuscitation from LAST and it also can decrease the effectiveness of lipid emulsion therapy
 - b. AVOID:
 - i. Vasopressin
 - ii. Calcium channel blockers
 - iii. Beta blockers
 - c. If a ventricular arrhythmia develops Amiodarone is the drug of choice
7. Lipid emulsion therapy
 - a. Bolus: 1.5ml/kg (lean body mass) 20% lipid emulsion, over 1 minute
 - i. Lean body mass= ideal body weight x 1.3
 - b. Infusion: 0.25ml/kg/minute, continued for at least 10 minutes after circulatory stability is attained
 - c. If circulatory stability is not attained, repeat bolus up to 2 more times and increase the infusion rate to 0.5ml/kg/minute
 - d. Upper limit for lipid emulsion: 10ml/kg over 30 minutes
 - e. Failure to respond: consider cardiopulmonary bypass

Lipid Emulsion Mechanism of Action

- Lipid sink: An intravascular reservoir that sequesters local anesthetics and decreases the plasma concentration
- Metabolic effect: Enhances myocardial fatty acid metabolism
- Inotropic effect: Increases calcium influx and intracellular calcium concentration
- Membrane effect: Impairs local anesthetic binding to voltage-gated sodium channels

Additional Notes:

- Safe in pregnancy
- Pancreatitis is a theoretical complication of lipid emulsion therapy due to hyperlipidemia and or hyperamylasemia
- Careful post-resuscitation monitoring is essential. If the duration of the local anesthetic exceeds that of the lipids, then hemodynamic instability may reoccur.

(Elisha et al., 2012) (Vargo, 2020)

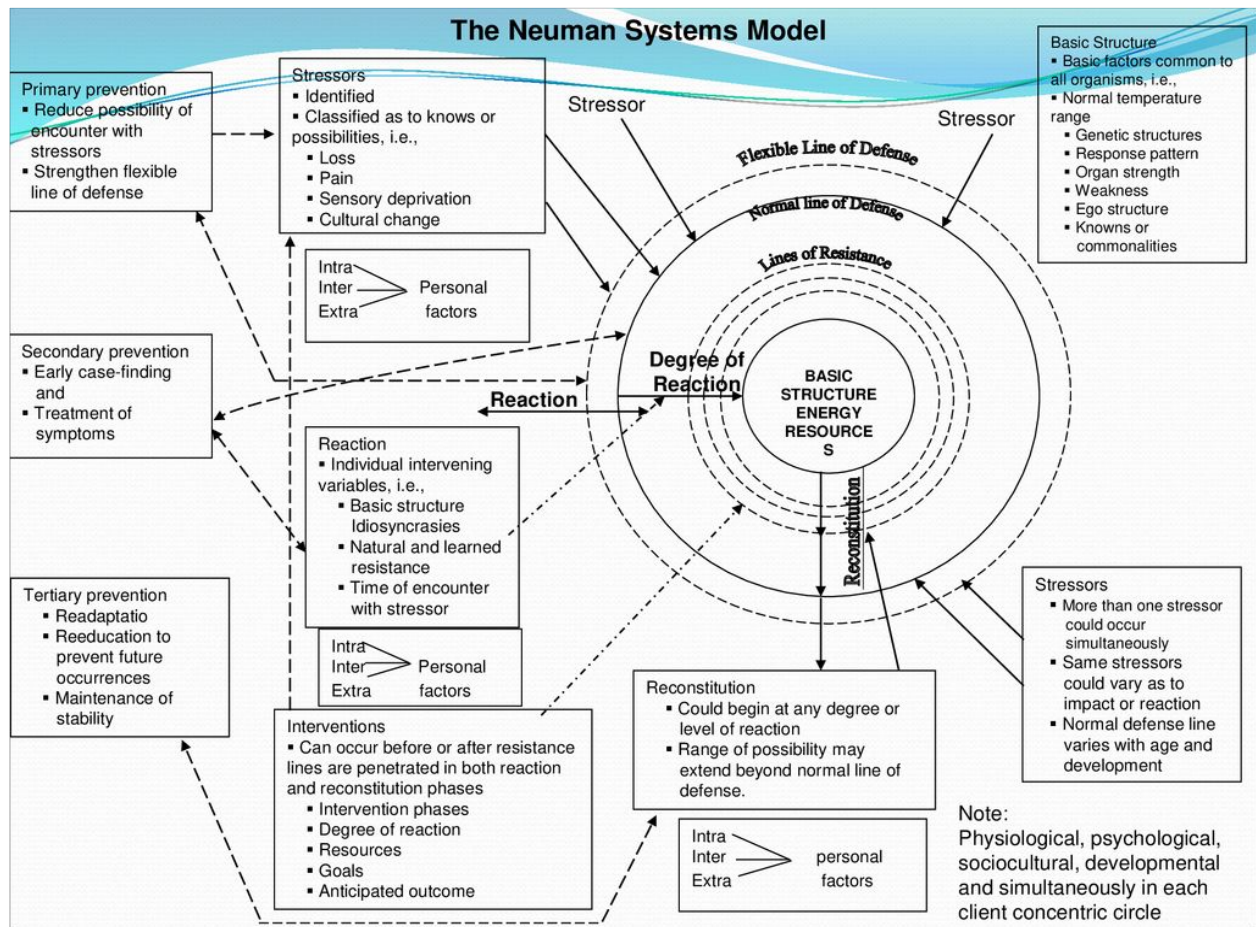
Appendix B

Lidocaine Infusion Test

1. Lidocaine is an ester/amide local anesthetic with a high/low risk of allergic reaction.
2. What is the mechanism of action of local anesthetics?
 - a. They block potassium channels intracellularly
 - b. They block sodium channels intracellularly
 - c. They block potassium channels extracellularly
 - d. They block sodium channels extracellularly
3. What is the appropriate lidocaine infusion rate for a patient with a BMI $<30\text{kg/m}^2$?
 - a. 2mg/min
 - b. 2mg/kg/h actual body weight
 - c. 1mg/kg/h actual body weight
 - d. 3mg/kg/h ideal body weight
4. What is the appropriate lidocaine infusion rate for a patient with a BMI $\geq 30\text{kg/m}^2$?
 - a. 2mg/min
 - b. 2mg/kg/h actual body weight
 - c. 2mg/kg/h ideal body weight
5. What is the appropriate lidocaine infusion rate for the following patient:
Height: 5'8 (172in; 1.7m) BMI: 34.6
Weight: 100kg Sex: Male
 - a. 2mg/min
 - b. 2.4mg/min
 - c. 3mg/min
 - d. 3.3mg/min
6. Under what lidocaine plasma concentration (mcg/ml) is considered therapeutic?
 - a. 5
 - b. 7
 - c. 10
 - d. 15
7. What is the initial bolus treatment for Local Anesthetic Systemic Toxicity (LAST)?
 - a. 1ml/kg 10% lipid emulsion bolus
 - b. 1.5ml/kg 10% lipid emulsion bolus
 - c. 1.5ml/kg 20% lipid emulsion bolus
 - d. 2ml/kg 20% lipid emulsion bolus

Appendix C

The Neuman Systems Model



(Semantic Scholar, 2011)

Appendix D

Aldrete Score

ALDRETE SCORING

A score of 8 required for transfer from PACU

Activity

- 2 points - moves all extremities
- 1 point - moves two extremities
- 0 points - unable to move extremities

Respirations

- 2 points - coughs and breaths deeply
- 1 point - shallow breath, dyspneic or limited breathing
- 0 points - apneic

Circulation

- 2 points - BP +/- 20 mmHg of pre-op level
- 1 point - BP +/- 20-50 mmHg of pre-op level
- 0 points - BP +/- 50 mmHg of pre-op level

Consciousness

- 2 points - Fully awake
- 1 point - Arousable to voice
- 0 points - Not responsive

O2 Saturation

- 2 points - SpO2 > 92% on room air
- 1 point - Supplemental oxygen required to maintain > 90%
- 0 points - Spo2 < 90% with supplementation

(Straight Nursing, 2017)

Data Collection Spreadsheet

Average Pre-Test Score	Average Post-Test Score

Assigned Patient Number	Lidocaine Bolus Was Given With Induction Per Protocol (Yes/No)	Lidocaine Infusion Was Initiated At The Proper Rate Per The Protocol (Yes/No)	Lidocaine Infusion Was Discontinued At The Proper Time Per The Protocol (Yes/No)	Complete Adherence To The Protocol (Yes/No)

[illegible][illegible]

Appendix F

Western Michigan University School of Medicine Quality Improvement Project Approval

**NON-HUMAN RESEARCH DETERMINATION**

July 27, 2020

Eric Howard, BSN, CCRN
Oakland University- Beaumont Graduate Program of Nurse Anesthesia

TYPE OF REVIEW: NON HUMAN RESEARCH DETERMINATION

PROTOCOL TITLE: A Quality Improvement Project: Understanding Compliance Post-Implementation of a Standardized Intraoperative Lidocaine Infusion Protocol at Ascension Borgess Hospital

Dear Mr. Howard:

On July 27, 2020, it was determined that the proposed activity does not meet the definition of research as defined by the Common Rule and FDA. The intent and scope of this project is to improve the quality of care at Ascension Borgess and is limited to Kalamazoo Anesthesiology. When presenting or publishing it should be presented as quality improvement not research.

The quality improvement project will be conducted at Ascension Borgess Hospital with permission and under the oversight of Robert D. Hilliard, MD, Chief of Staff. Per the HIPAA regulations no protected health information should be disclosed outside of the covered entity, Ascension Borgess Hospital, for this project.

This determination applies only to the activities described in the documents submitted to the WMed IRB.

If you should have questions regarding the status of your project, please contact the Office of the IRB at 269-337-4345 or e-mail irb@med.wmich.edu.

Sincerely,

A handwritten signature in black ink, appearing to read 'Parker Crutchfield'.

Parker Crutchfield, PhD
IRB Chair
Western Michigan University Homer Stryker M.D. School of Medicine
1000 Oakland Drive
Kalamazoo, MI 49008-8012

cc: Kayla Donnay
Lindsey Krueger
Robert Hilliard
Oakland University IRB

Appendix G

Letter of Support

**Institutional Support Letter**

To the Oakland University IRB:

I am familiar with Kayla Donnay, Eric Howard, and Lindsey Krueger's quality improvement project titled Intraoperative Lidocaine Infusions for Gastric Surgery. I understand Ascension Borgess' involvement is to provide historical/archival data through retrospective chart reviews.

I understand that this quality improvement activity to be carried out following HIPAA regulations and confidentiality of the data collected for this project will be maintained using de-identification strategies as described in the proposal.

Therefore, as a representative of Ascension Borgess, I agree that Kayla Donnay, Eric Howard, and Lindsey Krueger's QI project may be conducted at our institution.

Sincerely,

A handwritten signature in black ink, appearing to read 'Robert D Hilliard', written over a horizontal line.

Robert D Hilliard, MD

Chief of Staff
Ascension Borgess Hospital

Appendix H

Statistics Glossary

Descriptive Statistics

Descriptive statistics are typically used to describe or summarize the data. It is used as an exploratory method to examine the variables of interest, potentially before conducting inferential statistics on them. They provide summaries of the data and are used to answer descriptive research questions.

Mean (M): The average value of a scale variable.

Percentage (%): The percentage of the frequency or count of a nominal or ordinal category.

Sample Size (n): The frequency or count of a nominal or ordinal category.

Standard Deviation (SD): The spread of the data around the mean of a scale variable.

Independent Samples t -Test

The independent samples t -test is used to determine if there is a significant difference between two groups (e.g., men vs. women) on a scale-level dependent variable. This test uses the difference between the average scores of the two groups to compute the t statistic, which is used with the df to compute the p -value (i.e., significance level). A significant result indicates the observed test statistic would be unlikely under the null hypothesis. The independent samples t -test carries the assumptions of independence of observations, normality, and equality (or homogeneity) of variance.

Cohen's d : Effect size for the t -test; determines the strength of the differences between the matched scores. The larger the effect size, the greater the differences in the matched scores.

Degrees of Freedom (df): Refers to the number of values used to compute a statistic. The df is determined by the number of observations in the sample and equal the number of observations -

1; used with t to compute the p -value.

p -value: The probability of obtaining the observed results if the null hypothesis is true. A result is usually considered statistically significant if the p -value is $\leq .05$.

t -Test Statistic (t): Used with the df to determine the p value.

Appendix I

Timetable

Time	Task	Notes
May 2019-September 2019	Communication with various anesthesia providers and Oakland personnel regarding DNP project ideas and feasibility.	
July 2019	DNP Project Approval from Oakland University	
September 2019	DNP Project team members finalized	
November 2019- May 2020	Evaluation of the literature and IRB preparation	Contacted WMed's IRB- notified no IRB is needed since our project is a QI. Advised to go through Oakland University's IRB
May 2020	Contact Ascension Borgess 4N Nurse Manager for feasibility of charted findings Consult and hire Statistician Submit IRB to Oakland University	
September 2020	Kalamazoo Anesthesiology meeting for education and dissemination of protocol with supplemental e-mail	
October 2020	Initiate Intraoperative Lidocaine Infusion Protocol Begin baseline chart review	Chart review will include collecting and documenting any variables found in Appendix E
October 2020- January 2021	Chart Review of Dr. Verseman's patients who received the Intraoperative Lidocaine Infusion Protocol	Chart review will take place once a patient has been discharged from the hospital
February- April 2021	Compute and interpret Results Evaluate recommendations for future and limitations Prepare presentation for dissemination of findings	
May 2021	Dissemination of findings	Kalamazoo Anesthesiology Meeting (May 6); American Association of Nurse Anesthetists (August 2021); Michigan Association of Nurse Anesthetists (TBD)

Appendix J

Collaborative Institutional Training Initiative (CITI Program) Certifications



Completion Date 02-Sep-2019
Expiration Date 01-Sep-2022
Record ID 33054099

This is to certify that:

Kayla Donnay

Has completed the following CITI Program course:

Human Subjects Research (Curriculum Group)
Student and Faculty Advisor Basic/Refresher (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

Oakland University



Verify at www.citiprogram.org/verify/?wdd0fc974-d45b-481e-8281-25b12bef6645-33054099



Completion Date 07-Sep-2019
Expiration Date 06-Sep-2022
Record ID 33179235

This is to certify that:

Kayla Donnay

Has completed the following CITI Program course:

Human Subjects Optional Modules	(Curriculum Group)
Research and HIPAA Privacy Protections	(Course Learner Group)
1 - Optional Module	(Stage)

Under requirements set by:

Oakland University



Verify at www.citiprogram.org/verify/?w66dac289-dbf3-4189-8569-1a08f4c4e4cf-33179235



Completion Date 07-Sep-2019
Expiration Date N/A
Record ID 33179234

This is to certify that:

Kayla Donnay

Has completed the following CITI Program course:

CITI Health Information Privacy and Security (HIPS)

(Curriculum Group)

CITI Health Information Privacy and Security (HIPS) for Clinical Investigators

(Course Learner Group)

1 - Basic Course

(Stage)

Under requirements set by:

Oakland University



Verify at www.citiprogram.org/verify/?wb76e0817-878c-4999-8463-dcd8a98acb28-33179234



Completion Date 04-Sep-2019
Expiration Date 03-Sep-2022
Record ID 33116391

This is to certify that:

Eric Howard

Has completed the following CITI Program course:

Human Subjects Research

(Curriculum Group)

Student and Faculty Advisor Basic/Refresher

(Course Learner Group)

1 - Basic Course

(Stage)

Under requirements set by:

Oakland University

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wfeed9aa0-1d29-4e29-b670-e4046885d28c-33116391



Completion Date 05-Sep-2019
Expiration Date 04-Sep-2022
Record ID 33147206

This is to certify that:

Eric Howard

Has completed the following CITI Program course:

Human Subjects Optional Modules	(Curriculum Group)
Research and HIPAA Privacy Protections	(Course Learner Group)
1 - Optional Module	(Stage)

Under requirements set by:

Oakland University

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w138ae31c-fc5e-4ddf-92a4-c93e5b4a5ef2-33147206



Completion Date 05-Sep-2019
Expiration Date N/A
Record ID 33147205

This is to certify that:

Eric Howard

Has completed the following CITI Program course:

CITI Health Information Privacy and Security (HIPS)

(Curriculum Group)

CITI Health Information Privacy and Security (HIPS) for Clinical Investigators

(Course Learner Group)

1 - Basic Course

(Stage)

Under requirements set by:

Oakland University



Verify at www.citiprogram.org/verify/?wd3311650-764d-41ee-8cb0-4072c98404b9-33147205



Completion Date 08-Sep-2019
Expiration Date 07-Sep-2022
Record ID 33195487

This is to certify that:

Lindsey Krueger

Has completed the following CITI Program course:

Human Subjects Research	(Curriculum Group)
Student and Faculty Advisor Basic/Refresher	(Course Learner Group)
1 - Basic Course	(Stage)

Under requirements set by:

Oakland University



Verify at www.citiprogram.org/verify/?wc0a5ba1f-7112-451a-b573-85a7930fa944-33195487