Role of Multimodal Analgesia in Recovery and Acute Pain in Bariatric Surgery

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Abstract

Obesity affects pathophysiology causing cardiac, respiratory, and metabolic disorders. In modern societies, bariatric weight-loss surgical procedures are escalating, as surgery has become a treatment method for obesity. Pain management of obese patients can be challenging, and respiratory depression caused by opioids can lead to mortality in this population. Multimodal analgesia (MMA) consisting of multiple analgesics that act by diverse routes at different pain receptors providing synergistic analgesia, associated with opioid use alone is found to be of high quality and effectiveness. Multimodal analgesia has shown to improve pain management by decreasing doses and adverse effects of opioids and delivering quality analgesia that is safe and proficient. Use of MMA is an evidence-based practice guideline adopted by many anesthesia providers for the advantages of better pain management, lower healthcare costs, and earlier discharge. Providing efficient pain management impacts the society by improving quality of care and decreasing mortality after surgery. The aim of this pilot quasi-experimental project was to verify if the use of MMA improved pain control and decreased the length of stay for adult bariatric surgery patients during the last four years at a federal funded healthcare facility in the southwest. Analysis of the data revealed that there was no difference in the amount of opioids consumed or the length of stay between the opioid only and the MMA groups.

Keywords: Obesity, bariatric surgery, pain management, multimodal analgesia, opioid, synergistic analgesia.
Multimodal Analgesia in Adult Bariatric Surgery

The incidence of obesity is increasing so rapidly that it has become the second preventable cause of mortality in the United States (U.S) after smoking (Fencl & Walsh, 2015). In the U.S, 16.9% of children ages 2-19 are obese, and about 35% (one-third) of the adult’s population are obese (American Heart Association [AHA], 2014). Obesity causes hypertension, diabetes, heart disease, and pulmonary disease contributes to complications that prolong the length of stay (LOS) during hospitalization and affect the economy of the health care system drastically impacting the medical expense to be $147 billion (Centers for Disease control and Prevention [CDC], 2016; Selassie & Sinha, 2011). In modern societies, bariatric weight-loss surgical procedures have become a feasible approach for the treatment of obesity when traditional methods fail (Fencl & Walsh, 2015).

Project Background

Significance of the Topic

Opioids have been the traditional choice of analgesic used in surgery (Young & Buvanendran, 2012). The high dominance of obstructive sleep apnea (OSA) and opioid-induced respiratory depression in bariatric patients make safe analgesic management difficult (Schug & Raymann, 2011). In addition to respiratory depression, nausea, vomiting, itching, constipation and decreased gastric mobility are some of the unpleasant side effects of opioids that patients may experience after surgery (Chandrakantan & Glass, 2011).

Economic significance. Approximately 225,000 bariatric surgeries were performed in U.S in 2013, compared to 12,775 in 1998 (Fencl & Walsh, 2015). According to the 2012 report published by the International Anesthesia Research Society, a single opioid-related complication will cost a patient approximately $1000 (Soto, 2016). Opioid-related adverse events lead to a
47% increase in readmission, 55% longer hospital stay and 47% increase in the total cost of surgery (Soto, 2016).

**Policy and health system significance.** The implication of Multimodal analgesia (MMA) will profoundly decrease postoperative narcotic consumption by 73.8% (Ziemann-Gimmel, Hensel, Koppman, & Marema, 2013). The use of different analgesics helps to optimize analgesic efficacy and thus use reduce amount of a drug, thereby reducing the risk of dose-related adverse events (Gonzalez, & Ramamoorthy, 2014). Implementing MMA during the perioperative period will decrease the length of hospital stays by about a day, which would be a saving of $2,000 (Soto, 2016). It produces cost savings by reducing emergency room visits in the first 30 days postoperatively (Chaar, Stoltzfus, Claros, & Wasylik, 2016). The annual costs will be decreased by $105,204 if the MMA therapy is used instead of opioid only treatment (Izumi et al., 2013).

**Local Issue of Pain management in Bariatric Surgery**

In 2013 the federal institution estimated 135,000 veterans to be obese (U.S Department of Veterans Affairs [VA], 2013). Obesity related co-morbidities expense has been estimated to be $315 billion (Fouse & Schauer, 2016). The obese patients require 68% more medication to treat the co-morbidities than the regular population (Sánchez-Santos et al., 2013). Studies show that after bariatric surgery resolves the comorbidities by causing 86.6% reduction in diabetes, 79.0% decline in cardiovascular risks, 83.6% OSA diminution and 61.7% decrease in hypertension (Sánchez-Santos et al., 2013; Fouse & Schauer, 2016). Surgery reduces mortality rate by 40% and increase in survival rate (Sánchez-Santos et al., 2013; VA, 2013). Improved quality of life, better health, possibilities of better education and enhanced job performance are additional benefits of the surgery (Sánchez-Santos et al., 2013).
Diversity Considerations

This project was conducted at a federal funded healthcare facility. This is one of the largest federal institution in the southwest (U.S Department of Veterans Affairs [VA], 2016). It is the policy of the department to show no diversity due to race culture or creed (VA, 2016). Analyzing the veteran population, it has been found that most of the veterans are male and white who served the Vietnam War (VA, 2016). Over the next 25 years, the Gulf War veterans will become the predominant population being served at the (VA) hospitals (VA, 2016). As the women veterans are increasing, it is estimated that by 2040 the women veterans will be at least 20 percent of the patients seen at this institution (VA, 2016). Veterans are the vulnerable patient population (VA, 2016). Diversity in the veterans is a complex issue which cannot be fixed by a simple solution (VA, 2016). When conducting the research attention was paid to eliminate similar differences (Haider et al., 2016). At this facility the employees are trained to deal cultural diversity with equality and equity.

Problem and Purpose

Problem Statement

Pain relief is one of the measures of quality care (Garimella & Cellini, 2013). Obese patients have significant comorbidities, including hypertension, OSA, diabetes, cardiovascular disease and stroke (CDC, 2016). Therefore, effective pain management remains a challenge for bariatric patients undergoing surgery (Cullen & Ferguson, 2012; Fencl & Walsh, 2015). A review of the literature reveals the core concepts related to peri-operative pain management after bariatric surgery: pain management, a stability between pain relief, adverse effects, and knowledge (Garimella & Cellini, 2013). The plan was to educate the providers about the
advantages of multimodal analgesia (MMA) and assist in implementing this intervention (Manworren, 2015; Stevens, 2017).

**Intended Improvement with Purpose**

The evidence-based quality improvement (EBQI) project was envisioned to educate providers about the use of MMA which was an evidence-based practice guideline adopted by many institutions for the advantages of better pain management, lower healthcare costs and earlier discharge (Soto, 2016). Educating the providers to customize pain management adequate to the needs of bariatric patients with MMA is crucial for improved outcomes (Garimella & Cellini, 2013). MMA helps to reduce the opioid consumption, which helps reduce opioid-related adverse events like hypoxemia, nausea, vomiting, and the extent of stay, while improving patient contentment and offering efficient pain control (Soto, 2016; Au, Choi, Cheng & Leung, 2015; Salama & Abdallah, 2016; Ziemann-Gimmel, Hensel, Koppman & Marimba, 2013; Song, Melroy & Whipple 2014).

**Facilitators and Barriers**

This project was expected to be efficacious if the people were motivated to reject old practices and adopt new ones (Sutherland, 2013). In practice, this process needs continuous evaluation and open communication that will keep the change ongoing and productive (Sutherland, 2013). The key component of success in the implementation of this evidence-based practice (EBP) project is by involving leadership and collaboration of skills learned to overcome barriers using various communication techniques such as open communication, understanding perspectives, and developing patient-oriented solutions (Chism, 2010). The facilitators were my mentor an anesthesiologist and the quality improvement director. Barriers were the nurses and patient’s perception about pain relief. The preoperative teaching about attitudes and expectations
of pain, reporting pain, use of adjuncts to relieve pain and involving the patient in realistic goal setting was recognized to attribute towards the deliverance of effective pain management (Good & Moore, 1996; Peterson & Brewdow, 2009).

**Review of Evidence**

**PICOT**

In the adult with bariatric surgery, does evidence-based multimodal analgesia compared to opioids only decrease recovery time as measured by length of stay in the hospital and acute pain over a 3-day period post-operative period at the federal funded healthcare facility in the southwest?

**Literature Search**

A comprehensive, in-depth and exhaustive search of highly regarded databases was performed, to include Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, Cochrane Library, EMBASE, Science Direct, Medline Plus and Google Scholar. While the most current relevant studies were weighted most heavily, the search strategy included reviewing high-quality studies ranging from 2010 to 2017. Search terms included opioid and obesity, pain management in bariatric surgery, multimodal analgesia, multimodal analgesia in bariatric surgery, and enhanced recovery after surgery (ERAS). At the inception of the search, there were 120 potentially relevant studies found through title assessment. After multiple analysis 20 articles were considered valuable for components that supported general concepts of background information and were included in the evidence table (Appendix A).
Evidence by Sub-Topics

Theme/ Subtopics

The findings were categorized into four main groups: Enhanced recovery and use of MMA after Bariatric surgery, bariatric surgery and opioid-related adverse events, use of intravenous (IV) acetaminophen (APAP) and dexmedetomidine (DEX) in perioperative pain management, guidelines for post-operative pain management.

Enhanced recovery and use of multimodal analgesia after bariatric surgery. The guidelines for perioperative care were developed from studies showing MMA helps to promote enhanced recovery after surgery (ERAS). Malczak et al. (2017) conducted a qualitative meta-analysis which comprised a thorough evaluation of 11 articles out of 1151 articles. The aim of the analysis was to systematically appraise the evidence of ERAS pathways compared with the traditional pain management after bariatric surgery using primary outcomes like decreased opioid requirement, decreased pain scores, and length of hospital stay (Malczak et al., 2017). Malczak et al. analyzed the overall morbidity, mortality, readmissions and costs. Malczak et al. studied two groups that were the ERAS group and the control group. Malczak et al. analyzed the length of stay (LOS) and found a noteworthy decrease and the ERAS group had reduced LOS compared to the control group, p=0.002. The inquiry of overall morbidity and complications showed no substantial deviations among study group (Malczak et al., 2017). However, ERAS protocol reduced the general cost of hospitalization for surgery.

Gupta et al. (2014) piloted a retrospective pharmacoeconomic analysis of potential analgesic and cost effectiveness of using IV APAP in acute pain control after surgery (Gupta et al., 2014). The cost of IV APAP per patient, cost of other analgesics, pain scores by visual analog scores (VAS), LOS, patient satisfaction, and opioid related adverse event (ORAE) were
evaluated (Gupta et al., 2014). Group was compared with Chi squared test and p-values were reported (Gupta et al., 2014). Analysis showed that 80% received a combination of analgesics intra-operatively, 36% did not receive post-operative analgesic, and 19% had regional anesthetic nerve block. 88% did not have any adverse events, 6.25% has post-operative nausea and 1.25% had vomiting (Gupta et al., 2014). Using IV APAP increased the cost of analgesics, but was still cost effective as the side effects, amount of opioid use post operatively, and length of stay had decreased (Gupta et al., 2014). This study meets a grade of level 3 for synthesis of evidence.

**Bariatric surgery and opioid related adverse events.** Maund et al. (2011), performed a systemic review (SR) and a mixed treatment comparison (MTC) analysis. The study was to establish that non-opioid analgesic is useful in lowering morphine utilization and harmful outcomes (Maund et al., 2011). Sixty high-quality studies were chosen for this study (Maund et al., 2011). The control group patients received patient-controlled analgesia (PCA) morphine, and paracetamol, NSAIDs, or COX-2 inhibitors and the comparison group received PCA morphine and placebo (Maund et al., 2011). Maund et al. study observed that adding analgesics that are non-opioids, had a substantial decrease in opioid use (Maund et al., 2011. The group that had multiple analgesics had lower rates of gastrointestinal (GI) upset (Maund et al, 2011). Uses of IV paracetamol, NSAIDS, and COX-2 inhibitors hold an integral part in pain control, preventing GI complications (Maund et al., 2011).

Ziemann-Gimmel et al. (2013) steered a retrospective data analysis to determine whether MMA reduces narcotic consumption and had an influence on opioid-related side effects in patients undergoing gastric bypass surgery. Within the 181 patients studied, 89 patients obtained hydromorphone PCA, and the next 92 patients received IV APAP and IV Ketorolac every 6hrs for the first 24 hours (Ziemann-Gimmel et al., 2013). The study measured the relative risk of
opioids like nausea and vomiting (Ziemann-Gimmel et al., 2013). Patients with PCA required 4.2mg hydromorphone in the postoperative period while the patients in the non-opioid group required 1.1mg of hydromorphone, which is a 73.8% reduction of opioids (Ziemann-Gimmel et al., 2013). The requirement of an antiemetic was also decreased in the non-opioid group (Ziemann-Gimmel et al., 2013). The proposal of this study was that multimodal analgesic regimen can reduce postoperative narcotic use which may reduce the number of patients requiring antiemetic rescue medication postoperatively (Ziemann-Gimmel et al., 2013).

Sullivan, Lyons & Montgomery (2016) conducted a systematic review and meta-analysis to measure safety and value of non-opioids in trauma patients. A PubMed literature search provided 166 citations; an extensive evaluation was conducted for appropriateness, and 91 citations remained (Sullivan et al., 2016). The study found that pain and nausea was reduced by using non-steroidal anti-inflammatory drugs (NSAIDS) instead of opioids (Sullivan et al., 2016). Alpha-2 adrenergic agonists are medications that provide sedation and relieve anxiety (Sullivan et al., 2016). Addition of non-pharmacological approaches such as cryotherapy, diversion methods, meditation, music, and acupuncture will improve the benefits of MMA (Sullivan et al., 2016).

**Acetaminophen and Dexmedetomidine in peri-operative pain management.** A prospective, double-blinded randomized controlled trial (RCT) was directed by Salama & Abdallaha (2016) to estimate the results of coalescing DEX infusion and oral pregabalin, pain score, and hemodynamic values post bariatric surgery. Total of 67 morbidly obese patients were enrolled in the study (Salama & Abdallaha, 2016). Seven patients were omitted by exclusion criteria and sixty patients were randomized for the study (Salama & Abdallaha, 2016). Group A received pregabalin and DEX while group B received placebo post-operatively (Salama &
Abdallaha, 2016). The researchers determined that there was no substantial change in the oxygen saturation during recovery. The mean heart rate and blood pressure were significantly lower in group A (Salama & Abdallaha, 2016).

Saurabh et al. (2015) executed a quantitative retrospective review of charts during the year 2011-2013, of laparoscopic gastric bypass surgery patients. In the Saurabh et al study 183 patients were detected who obtained APAP in addition to morphine PCA and the control group consisted of 229 patients who received only morphine PCA. During the first 24hr the after gastric bypass, the group that received IV APAP had 25% reduction in opioid use (Saurabh et al., 2015). The use of APAP reduces opioid consumption that supports the routine use of MMA including APAP in bariatric surgery (Saurabh et al., 2015).

Song et al. (2014) steered a quantitative retrospective review of medical records 104 patients who had laparoscopic sleeve gastrectomy and gastric bypass surgery. Patients were assigned equally into two groups, group 1 received IV APAP 1gm every 6 hourly and group 2 received no IV APAP post-operatively (Song et al., 2014). The study results showed that the group that received APAP required lesser amounts of morphine equivalents (Song et al., 2014). IV APAP group were discharged early and had a quicker return of bowel sounds. Pain scores were same in both the groups (Song et al., 2014).

Booth et al. (2016); Anderson et al. (2014) led a qualitative RCT evaluating MMA technique in patients after cesarean section. Seventy- four parturients scheduled for surgery were enrolled in the study (Booth et al., 2016). The interventional group obtained 300mcg morphine in the subarachnoid block (SAB) and 1gram APAP every 6 hours for 24 hours post-operatively (Booth et al., 2016). Control group patients got half the dose of morphine in their SAB and placebo tablets (Booth et al., 2016). Results proved that increasing the dose of morphine along
with APAP provided significantly lower pain scores (Booth et al., 2016). There was no variance in the persistent pain or depression in both the groups (Booth et al., 2016).

Ren et al. (2015) conducted a quantitative double-blinded, RCT of ninety women in the age 35-65 years who underwent an abdominal hysterectomy. The goal was to determine the use of DEX as an adjunct for pain management (Ren et al., 2015). Patients selected had to meet the inclusion and exclusion criteria (Ren et al., 2015). Eight two patients were randomized into three groups D1, D2 and C, by a computer-generated table (Ren et al., 2015). Each group received different amounts of sufentanil and DEX (Ren et al., 2015). The study proved that adding DEX with opioid linked to less opioid consumption, effective pain control, and better patient gratification (Ren et al., 2015).

Schnabel, Meyer-Friebem, Reichl, Zahn and Pogatzki-Zahn (2013) conducted a meta-analysis of RCT to clarify the value and efficiency of administering DEX for acute pain management. Twenty-eight RCT included 1420 patients (Schnabel et al., 2013). Administration of DEX provided better pain control (Schnabel et al., 2013). The pain score was lower (-1.59U (numeric rating score) 95% confidence interval (CI): -2.37 to -0.82; P=.000001), opioid consumption was decreased (-17.24mg; 95% CI: -24.38 to -10.10; P=.000001), opioid-related side effects were lowered (Nausea: 0.6; 95% CI: 0.43 to 1.02; P=.06) (Schnabel et al., 2013). Bradycardia was noted in some patients after receiving DEX. (Schnabel et al., 2013)

Ong et al. (2010) guided a systematic literature search of all RCT on studies comparing the effect of paracetamol alone or paracetamol with NSAID combination. Twenty-one studies with 1909 patients were separated into two groups and examined (Ong et al., 2010). The research provided data that proves the combination of paracetamol and NSAID compared paracetamol alone has a higher efficiency 85% and 64% respectively (Ong et al., 2010). The
strength of the pain was 35.0% +/-26.6%, and the need for rescue analgesia was 38.8%+/-13.1% reduced correspondingly (Ong et al., 2010). The study supports the use of MMA in acute pain relief. (Ong et al., 2010)

Au et al. (2015) provided a comprehensive SR and meta-analysis of the RCT on combining analgesics. The study analyzed safety and effectiveness of MMA for pain management after oral surgery (Au et al., 2015). Fourteen studies with 3521 patients were divided into ten groups of different analgesic combinations (Au et al., 2015). The Cochrane Q value was p<0.0001 showing homogeneity in the treatment (Au et al., 2015). Due to the different combinations of analgesics, the I² value was analyzed, and it was 0.0% which shows less to moderate heterogeneity (Au et al., 2015). This study provides great evidence to support the use of MMA (Young & Buvanendran, 2012).

Gamboa and Nunez (2016) performed a literature review and found 314 articles related to the use of MMA in pain management. Thirty-four studies were used for this study that aligned with this project (Gamboa & Nunez, 2016). Amalgamation of analgesics such as DEX, NSAIDs, ketamine, APAP and local anesthetic infiltration show a lower requirement of opioids post-operatively, this study aligned with the purpose of the author’s capstone project, but the evidence level of this study was low due to limitations of the literature review (Gamboa & Nunez, 2016).

**Guidelines for post-operative pain management.** The guidelines for postoperative pain management were developed after conducting 107 systematic reviews and 858 primary studies researched (Gordan et al., 2016; Chou et al., 2016). The outcomes of interest, which is adequate postoperative pain relief is evident, and the recommendations are clearly stated (Melnyk & Fineout-Overholt, 2015, adapted).

The recommendations were drafted from a systematic evidence review process (Chou et
al., 2016). A multidisciplinary expert panel consisting of members of The American Pain Society (APS), developed the guidelines (Chou et al., 2016). They evaluated several different facets of postoperative pain management and cited the strength of the evidence for each recommendation that they made. After multiple rounds of revision, the recommendations were submitted and approved by the American Society of Regional Anesthesia (ASRA) board of directors in 2015 (Chou et al., 2016).

Theory

The Middle-Range Theory of Acute Pain

The middle-range theory of acute pain was set according to the Agency for Health Care Policy and Research (AHCPR) strategies, and it provides clear recommendations for nurses and physicians to follow (Good, 1998). This theory aims to attain an equilibrium between analgesia and side effects when nurses manage acute pain (Good, 1998). According to the theory, pharmacological, nonpharmacological adjuvants, and patient education help to control pain (Good, 1998). According to Good the theory is composed of three propositions multimodal intervention, attentive care, and patient participation (Appendix B). These three proposition form the elements of acute pain management (Chou et al., 2016). These components correlate with the nursing process: assess, diagnose, plan, implement, evaluate, that are well understood by clinicians.

Method

The evidence-based project was implemented at the VAHCS focusing on adult patients who underwent a gastric sleeve procedure at the facility.
Institutional Research Board

This was evidence-based quality improvement (EBQI) project. To structure a viable process of implementing change within a large health system, Institutional Review Board (IRB) approval was sought before the implementation of this EBP. Approval from this federal institution was requested before the data collection. This approval was given through the IRB as a quality improvement project. This was a retrospective chart review, therefore; no consent was needed.

Funding

Initially a cost of $1800 (Appendix C) was anticipated to provide interprofessional education regarding project results and recommendations for adoption of a MMA policy for surgical patients. At this time, there are no plans for dissemination of results that would require monetary support, as such, no grants funds have been requested for the project. Further research is recommended on this topic.

Ethical Issues

Bariatric patients were given the respect and quality of care identical to other surgical patients. Managing the pain after bariatric surgery with MMA provides justice to these patients (Saarmi et al., 2011). Patient’s privacy and confidentiality was maintained always. Data collected was kept in a safe place on a password protected health system computer. Charts were reviewed only to obtain the required data and no personal information.

Setting and Participants

The evidence-based project was conducted at a federal funded healthcare facility in the southwest. The project focused on adult patients who underwent robotic gastric sleeve procedure at this facility. The plan was to have fifty patients in each group.
Inclusion and Exclusion Criteria

Inclusion criteria were patients ages 18-70 with an ASA classification between 1-3 who were not pre-operatively on chronic opioid therapy, and underwent robotic gastric sleeve surgery during the last four years at this federal institute. Patients with ASA score of 4, older than 70 years, on chronic opioid therapy and who converted to open gastric sleeve surgery due to intra-operative complications were excluded from the study.

Intended Intervention and Steps

The proposed intervention was to use MMA by combining pharmacological agents with non-pharmacological adjuncts. Use of different medications such as non-opioids and local anesthetics along with opioids help to minimize the use of opioids for postoperative pain control (Au, Choi, Cheng & Leung, 2015; Ong, Seymour, Lirk, & Merry, 2010; Chou et al. 2015; American Society of Anesthesiologists [ASA], 2012).

The study focused on patients undergoing robotic or laparoscopic gastric sleeve surgery. Understanding co-morbidities and effects of opioids on obese patients leads to safe delivery and appropriate pain management (Ward, 2015). Studies have shown that use of MMA with IV APAP and DEX decreases the administration of opioid for post-operative pain control. Tailoring analgesics to the needs of morbidly obese patients, decreases side effects, facilitates better pain control, increases patient satisfaction and facilitates early discharge (Manworren, 2015).

A project time (Appendix D) line was calculated and designed to assist in completing the project in a timely manner. Initially a site contract had to be initiated. During June-July IRB approval process began. After the IRB approval, the student investigator (SI) performed the retrospective chart review using a sample size with priori power of .8, medium effect, and .05 alpha. Patient cases which met inclusion criteria were selected for review. A quantitative
comparison was made between two groups (control group - received only opioids and experimental group - received multimodal analgesia) during the intraoperative period.

Pre-operative and intra-operatively data was gathered by reviewing electronic medical records. Patient demographics, health history, length of surgery, dose of DEX and IV APAP will be collected. Post-operatively data was obtained on amount of opioid use, pain scores for the first 24 hour post-operatively according to the numerical rating scale (NRS) which was documented on the nurse’s note, the number of days in the hospital. Patient’s privacy and confidentiality was maintained at all times. The chart review took approximately three months to be completed. Following the data collection analysis of data was performed. Assistance from a statistician confirmed accuracy of data analysis.

The goal was to offer post data education all the anesthesia providers about the benefits of MMA. The terminal goal of this quality improvement (QI) project was to analyze the data on MMA and formulate a recommendation for policy and/or practice change. The medium range goal, which is not measured in this project, was a policy and/or practice change using MMA. Participant flow chart (Appendix E) shows the steps involved.

**Change Process**

**Lewin’s Change Theory**

Kurt Lewin’s change theory was intended to change certain per-operative guideline in pain management by breaking barriers in accepting change during the implementation process (Sutherland, 2013). This theory assists to identify steps that will contribute to developing strategies to enable the driving forces to be stronger than the forces that cause barriers towards moving forward (Sutherland, 2013). Lewin’s change theory has three steps. The first phase the unfreezing stage, helped to identify the focus (pain management) that needs a change
(Sutherland, 2013). In this phase, communication was imperative to foster the trust of the peri-operative team to help in decision-making (Sutherland, 2013). Moving stage was where the retrospective study and data collection took place. The third stage was the refreezing stage where the data was evaluated. The data didn’t show any expected outcomes therefore; no education of the providers will be implemented.

**EBP Model, The Rosswurm and Larrabee Model**

The Rosswurm and Larrabee (1999) EBP change model was selected as a pragmatic theory driven framework for a systemic process to bring about change because of this project. The model was composed of six elements that align to this project (Appendix F).

**Study design**

This quality improvement project was a quasi-experimental study. The study group consisted of patients who underwent robotic or laparoscopic bariatric surgery with opioids only as pain management and the comparison or control group consists of patients who received MMA for pain control after the same surgery. A logic model (Appendix G) was designed to outline the process of the EBP implementation.

**Validity**

**Internal and external validity.** The Numeric Rating Scale (NRS) has been shown to be invariant and not influenced by bias (Hawker et al., 2011). This scale is used widely by nurses for different surgeries proving its construct validity (Hawker et al., 2011). Maintaining the same patient demographics, surgeon, nursing staff, hospital policies and anesthesia team helped to keep the surgical environment similar between the two groups compared thus, maintaining the internal validity (Ferreira-Valente, Pais-Ribeiro, & Jensen, 2011). This study included only
veterans who represent a vulnerable population. Therefore, there was threats to external validity therefore, the results may not be replicated in general population.

**Project Outcomes and Measurement Instruments**

Numeric pain rating scores (NRS) and length of stay after bariatric surgery were the primary patient outcomes measures. The NRS provides a numeric rating of pain intensity on a scale (Appendix H) (Hawker, Mian, Kendzerska, & French, 2011). NSR has been nationally accepted and is used at this federal institution. This is the tool which the student investigator (SI) used for the pain assessment for this project. To examine the difference in LOS electronic health records were reviewed to calculate time elapsed from admission to discharge.

**Quality of Data**

The primary outcome of this project was to measure pain and length of stay after bariatric surgery. Interval level data like pain score, LOS, opioid consumption was compared between the experimental group that received MMA and the control group that received opioid for pain management. Pre-operative and intra-operatively data were gathered by reviewing electronic medical records. Post-operatively normal level data including amount of opioid consumption, pain scores for the first 24-hour post-operatively according to the NRS which is documented on the nurse’s note, the duration of hospitalization, and admission to intensive care unit (ICU) were collected. Demographic data such as age, gender, and BMI were also collected to be able to show that the samples are similar. Pain was a subjective therefore, the level of nurses experience, perception of patient pain, and documentation of pain score can all affect data quality.
Analysis

The intervention participants were the patients for this study. To determine the sample size, priori power was calculated using the perimeters of .8 power, medium effect, and .05 alpha. A power analysis was done to identify the required number of participants to create statistically valid outcome data within the study. During analysis the figures indicated that the distributions of the measures were skewed. A non-parametric test such as the Mann-Whitney test was considered for this project. This test was appropriate for comparing median values across two different independent groups. Median for each of the three measures such as the LOS, and the amount of opioid administered intra and post operatively were analyzed. A statistician was used to perform the final analysis.

Results

Setting and Participants

The retrospective study was conducted at a federal funded healthcare facility in the southwest. To meet the determined sample size, patients who had undergone laparoscopic or robotic gastric sleeve surgery patients from the year 2014-2017 were considered for this study. Patients who met the criteria were included in the study. The surgery was performed by a single surgeon. The objectives of this report were to summarize the demographic data, compare the length of stay, intra-operative morphine equivalent, and post-operative morphine equivalent of the two groups of patients in the study. All analyses were performed using IBM SPSS Statistics v. 25. The data contained information on two groups of bariatric patients, one group used opioids only for pain control (47 patients), and the other group used multimodal analgesia (MMA; 52 patients). Several demographic and other background measures were taken on the patients, including BMI, age, gender, ASA, tobacco use, and length of surgery.
**Intervention Course**

The intervention steps taken for this EBP project were as follows:

1. **Obtaining consent:** Initially a consent had to be taken from the federal institute nursing research department for conducting a study for an evidence-based quality improvement project. The problem statement, description of the project, goals or proposed results and proposed benefit to the institution by the project were explained in the proposal. Once the approval was granted the student investigator (SI) obtained the site approval between the federal institution and UMKC. This process required about three to four months.

2. **Reviewing charts:** To the meet determined sample size a list of patients who underwent gastric sleeve surgery by the specific surgeon were identified by the help of the clerk in the surgical services department. All the patients list from 2014-2017 were extracted. Approximately 150 charts were reviewed. Eligible patients were identified using the inclusion and exclusion criteria at the beginning of the project. Chart review yielded 47 patients in the opioid only group and 52 patients in the MMA group.

3. **Data collection:** Confidentially was maintained by de-identifying patient data that was extracted from identified medical records. Patient demographic information, length of hospital stays, and history of opioids administered intra and post-operatively were obtained and collected on the UMKC remote lab SPSS site.

4. **Data Analysis:** The data was analyzed, and results were obtained. A statistician was used to confirm the results.

5. **Results:** The results did not show noteworthy difference between the groups therefore further research is suggested in this project to evaluate the areas that may have affected the results.
Outcome Data

The data contains information on two groups of bariatric patients, one group which used opioids only for pain control (47 patients), and the other group which used multimodal analgesia (MMA; 52 patients). Several demographic and other background measures were taken on the patients, including BMI, age, gender, ASA, tobacco use, and length of surgery. These measures are summarized in Appendix M, Tables 1 – 6, and are separated by group for easy comparison. This table includes means, medians, and standard deviations. Patient BMI appear to be very similarly distributed between the two groups of patients. Table 2 includes summary statistics for patient ages. While the patients were typically slightly older in the opioids only group, the differences were not significant, and the overall distribution was quite similar. Table 3 provides the distribution of genders within each of the two groups. The opioids only group was 36.2% female, while the MMA group was 42.3% female. Both groups had a slightly majority of male patients. ASA is related to the severity of a patient’s condition. Table 4 shows the conditions of patients in each group. Generally, patients in each group had severity level of three. There was one patient in the opioids only group with an ASA of two, and one patient in the MMA group with an ASA of four. Table 5 shows that 42.6% of patients in the opioids only group have never used tobacco. This is lower than in the MMA group, where 61.5% of patients never used tobacco. There was one patient in the MMA group who was a current user of tobacco. This patient was not a smoker, but the patients chart indicated that he dips and sniffs. Table 6 provides summary statistics of length of surgery. The two groups have very similar distributions of length of surgery.

Statistical analysis. There are three measures we are interested in comparing statistically between the two patient groups in this report. Those were
1) length of stay 
2) intra-operative morphine equivalent, and 
3) post-operative morphine equivalent.

A summary of the statistics for each of these measures is shown separately in Table 7, for each of the two patient groups. In determining the appropriate test for a simple comparison between the two groups (without adjusting for other factors), initially it was determined whether these data are normally distributed within each of the groups. The histograms in figures 1, 2, and 3 show the number of patients who fall into different ranges of values. The number of individuals is indicated by the heights of the bars. In Figure 1a, the tall bars over the values near 50 indicate there a lot of patients with values of length of stay near 50, and the shorter bars over the values near 100 indicate there are fewer patients with values of length of stay near 100.

A histogram of a normal distribution would appear to have a symmetric, “bell shaped” appearance. But in this project analysis the figures indicate, in each case, that the distributions of these measures were quite skewed; they were positively (or right) skewed, meaning that most patients’ measures are not very large, but there were a few people whose measures were quite large compared to the typical patient. The data do not appear to be normally distributed.

While there were several ways to approach non-normal data, SI proceeded by using non-parametric tests that do not require the data to have any distribution and are tests of the median. Mann-Whitney test was used for each of the three measures. This test was appropriate for comparing median values across two different independent groups of subjects.

There was no statistically difference in length of stay at the 0.05 level of significance (Z = -0.86, p = 0.39), no evidence that the two groups have different median lengths of stay and no statistically difference in intra-operative morphine equivalent at the 0.05 level of significance (Z
There was no evidence that the two groups have different median intra-operative and post-operative morphine equivalent at the 0.05 level of significance ($Z = -0.10, p = 0.92$). Figures 4, 5, and 6 are bar plots demonstrating the medians of each group and show the practical difference across the two groups in this sample. The differences did not appear to be very large in a practical sense and reinforce the non-significant statistical results.

**Missing Data**

During the chart review SI noted that the nurses were inconsistent in recording the pain scores when administering the pain medication post-operatively. It was observed during data collection that the nurses gave the ordered opioids regardless of pain scores. No documentation was made about other methods of pain relief such as music, massage, meditation and ambulation. All the patients went to an intensive care unit for recovery due to OSA therefore, there was no documentation as to how long it required them to transition from recovery to a floor or home. The EMR did not record patient race therefore, SI could not determine if race had an impact on the pain scores. The patients who stayed in the hospital for a long time did not have supporting data in the chart as to why, such as, post-operative complication, uncontrolled pain, or difficulty in finding a discharge destination.

**Discussion**

The Doctorate of Nursing Practice (DNP) project was successful as it was a retrospective chart review and once the approval process was completed it was easy to access the charts. The patient charts are all electronic therefore it was a straightforward process to review the data and collect them. Special attention was made to maintain confidentiality of the patient information. Cooperation from the surgical services clerk and the information technology (IT) department made the project practical and accessible.
Study Strengths

The intervention use of MMA has been implemented by some anesthetists, therefore it was uncomplicated to obtain cases that had MMA during their surgery. The traditional method of using opioids only is also in practiced by some clinicians. The study participants were operated by the same surgeon which made the study data more concrete. All the patients were veterans and most of the patients were of ASA 3 which made the patient population similar. The anesthesia department at the federal institute is open to new practices as the use of MMA along with opioids. Therefore, there were no hindrances noted in implementing MMA for bariatric patients. The pharmacy, surgeon and anesthesiologist were all in accord with the use of MMA in bariatric surgery.

Results Compared to Evidence in the Literature

Multiple studies were used to compare the results with this project. Malczak et al., 2017 conducted a meta-analysis on recent studies done on the use of ERAS in bariatric surgery. Primarily 1151 articles were found that met the criteria but only 11 studies were chosen after careful elimination (Malczak et al., 2017). There were 5230 participants within these studies and out of that 3475 were ERAS and 1755 were non-ERAS (Malczak et al., 2017). All patients had undergone bariatric surgery (Malczak et al., 2017). In depth analysis was performed by the authors to evaluate if there was any difference in overall morbidity, mortality, post-operative complications, readmissions and economical benefit between the study groups (Malczak et al., 2017). The study showed decreased LOS but no significant difference in other areas of interest (Malczak et al., 2017).

The final assessment and conclusion of the meta-analysis was the necessity of a definite peri-operative protocol that involves the surgery team, anesthesia personnel, nursing, pharmacy,
physical therapy and patient (Malczak et al., 2017). Selecting the patients prudently will also impact the patient outcomes (Malczak et al., 2017). A training program which includes sequences of workshops and boot camps for the perioperative team before executing the ERAS protocol which includes the use of multimodal analgesics is essential in gaining compliance, cultivating patient safety, and outcomes (Malczak et al., 2017).

Wang et al., 2014 directed a retrospective study on the effect of IV APAP on narcotic use after obesity surgery. Total of 88 patients were identified in two groups (Wang et al., 2015). The opioid plus APAP and the opioid only group had 44 patients each (Wang et al., 2015). The results showed that pain scores or LOS between the groups was insignificant (Wang et al., 2015). In fact, the APAP group required a higher amount of opioids post operatively (Wang et al., 2015). Wang et al, stated that the limitations of the study were due to the sample being small, the inconsistency in the type of opioid use between the two groups, the BMI between the groups, and the study being retrospective may have contributed to the results (Wang et al., 2015). A prospective, randomized, double blind study will be essential to prove the results (Wang et al., 2015).

**Study Limitations**

Several limitations were identified in this study. This was a retrospective study carried out at a single healthcare facility.

**Internal Validity.** There was no specific patient selection or patient education about MMA for this surgery. The preoperative teaching about attitudes and expectations of pain, reporting pain, use of adjuncts to relieve pain and involving the patient in realistic goal setting is recognized to attribute towards the deliverance of an effective pain management (Good &
MULTIMODAL ANALGESIA IN ACUTE PAIN MANAGEMENT

Moore, 1996; Peterson & Brewdow, 2009). Involving patients in their pain management provides better results.

It was difficult to compare pain scores between groups due to variations in pain score documentation by the nursing staff. The nurse’s opinion and bias could have affected the documentation of pain score. There was no consistency in the post-operative opioid administered. Hydromorphone, morphine, oxycodone, hydrocodone and APAP were some of the analgesics used. It was noted that different doctors prescribed different medications. There was no consistency in pain medications prescribed post-operatively.

The anesthesia providers were not educated on the use of MMA or the timing of administration of DEX or APAP intraoperatively. These medications were administered at separate times after the start of surgery. If the surgery was unexpectedly prolonged due to unexpected reasons the post-operative effects of the MMA could have reduced.

Nurses were also not trained on the benefits of MMA and may have administered opioids irrespective of the pain scores as it was ordered. Early ambulation and other therapies help in pain control after laparoscopic or robotic surgery.

The LOS varied significantly between the groups and there was not enough documentation to know why some patients stayed longer than the others. There were no clear discharge criteria set which could have affected a delay in discharge in some cases. There was no preoperative education for the surgical team or the patients.

**External Validity.** This was a single center study. This federal institution is a large institution that treats only veterans. Veterans are an exclusive group of patients that have specific needs that are different from the general population. There are no previous studies that focus only on veterans. Studies have shown that about 50% of veterans suffer severe pain higher
than the civilian and they are on pain medications chronically (Nahin, 2017). Patients who are chronically on opioids for pain relief may require higher dose of opioids for acute pain management. SI didn’t evaluate the participants of the study to find if they had any chronic conditions that required them to be on opioids.

**Sustainability and efforts to minimize the study limitations.** The results did not show any major difference between the groups. Therefore, further intervention was not needed. The project raised the awareness and importance of creating a standardized protocol for bariatric surgery which involves the patient, surgical team and physical therapy for consistency, patient participation and better outcomes (Malczak et al., 2017). Carefully selecting the patients who can adhere with the protocol can maximize patient safety and better results (Malczak et al., 2017). The ERAS committee is in the process of developing a protocol which would involve the use of MMA and then educate the surgical team.

**Interpretation**

This EBP sought to understand the impact of MMA on opioid consumption, improve pain control, decreasing length of stay, and decrease morbidity and mortality. The project showed no statistical difference in the LOS or the opioid consumption between the opioid only and the MMA group. Good (1998) states that the Middle Range Theory is composed of three propositions (multimodal intervention, attentive care, and patient participation). The results of this project were directly influenced by the lack of education and involvement of the patient and the surgical team in the preoperative period. It is anticipated that future establishment of a preoperative protocol for bariatric surgery patients could deliver improved results.
**Intervention Effectiveness and Revision**

This study was done at the federal funded healthcare facility in the southwest where the patients are only veterans. The surgery was done by the same surgeon. The participants all underwent the same kind of surgery (robotic or laparoscopic sleeve gastrectomy). The nurses, anesthesia providers and the resident doctors did change during the period selected for the study. Studies show that MMA helps to reduce the opioid consumption and thereby reduce opioid-related adverse events like nausea, vomiting, length of stay and improve patient satisfaction (Au, 2015; Salama, 2016; Ziemann-Gimmel, 2013; Song, 2014). Use of IV APAP can increase the cost of analgesics, but the overall cost is reduced as it decreased adverse events caused by opioids and decreased the length of stay (Malczak, 2017; Gupta, 2014). Medications such as DEX and APAP were easily accessible by the anesthesia providers when needed. Incoperating peri-operative education along with the standardized MMA protocol could possible impact future results. Selecting the patients judiciously and reviewing the history of opioid dependence may also help in decreasing the LOS, opioid consumption, and improving patient outcomes.

**Expected and Actual Impact to Health**

Use of MMA is an evidence-based practice guideline adopted by many institutions for the advantages of better pain management, lower healthcare costs and earlier discharge (Soto, 2016). Implementing the use of MMA was expected to reduce the side effects of opioids (Vadivelu, Mitra, & Narayan, 2010). In this EBP SI was unable to record any side effects from opioids due to the inconsistency of the nurses in recording them in the note. MMA helps to reduce the opioid consumption, which helps reduce opioid-related adverse events like hypoxemia, GI upset, and the duration of hospitalization, while improving pain control (Soto, 2016; Au, Choi, Cheng & Leung, 2015; Salama & Abdallah, 2016; Ziemann-Gimmel, Hensel,
Koppman & Marimba, 2013; Song, Melroy & Whipple 2014). The data in this EBP showed no meaningful difference in the LOS and the amount of opioids consumed.

**Health System, Costs, and Policy**

The expected outcome of the EBP was that it would decrease the LOS and the amount of opioid consumption in bariatric surgery patients. This study showed no major difference in the outcomes between the two groups. This was a retrospective study with no cost for the project except the time and effort put forth by the SI. Due to the findings no protocol was initiated, yet suggestions were made for future research in this area with more details.

**Conclusion**

**Practical Usefulness of Intervention**

The study focused on patients undergoing robotic or laparoscopic bariatric surgery as the gastric sleeve surgery. Understanding pathophysiology of obese patient’s and adverse effects of leads delivery of safe and appropriate pain management (Ward, 2015). Tailoring analgesics to the needs of morbidly obese patients, decreases side effects, facilitates better pain control, increasing patient satisfaction and facilitating early discharge (Manworren, 2015).

**Further Study of Intervention**

The evidence-based intervention, use of MMA, with IV APAP and DEX decreases the administration of opioid for post-operative pain control could potentially be used in other surgeries and trauma. The anticipated outcome was that the use of multimodal analgesia causes dose reduction and adverse effects of individual analgesics especially opioids. This EBP did not show any substantial difference between the two groups of patients. Therefore, it is suggested to do further research on this area among the veterans after a standardized protocol has been
established and the surgical team is educated on the expectation along with patient education and involvement.

Further implementation of the evidence must be done in infants, elderly and patients with liver and renal failure. Once the expected outcomes are found the EBP can be disseminated by educating providers about MMA advantage such as effective analgesia, better outcomes, increase patient satisfaction and improving the economy of the health care system. Additionally, SI has submitted my project to the institutions newsletter named Vigil for publication. SI will be applying in June to present this project at the Postgraduate Assembly in Anesthesiology in New York which will be conducted in December 2018.

Definition of terms (Appendix H) will help to understand the terms clearly.
References

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http://dx.doi.org/10.1097/MD.0000000000001348


## Appendix A

**Itemized Budget for educating about Multimodal Analgesia**

<table>
<thead>
<tr>
<th>Item</th>
<th>Direct Cost</th>
<th>Indirect Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intravenous tubing sets</td>
<td>$20.00</td>
<td></td>
</tr>
<tr>
<td>Pumps</td>
<td>$250.00</td>
<td></td>
</tr>
<tr>
<td>Syringes</td>
<td>$30.00</td>
<td></td>
</tr>
<tr>
<td>Laboratory costs</td>
<td>$120.00</td>
<td></td>
</tr>
<tr>
<td>Needles</td>
<td>$10.00</td>
<td></td>
</tr>
<tr>
<td>Pamphlets for education</td>
<td></td>
<td>$300</td>
</tr>
<tr>
<td>Food for lunch during in-service</td>
<td></td>
<td>$300 for five in-services</td>
</tr>
<tr>
<td>Clinician training time</td>
<td></td>
<td>$1000</td>
</tr>
<tr>
<td>Flyers for advertisement of in-services</td>
<td></td>
<td>$200</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>$430.00</strong></td>
<td><strong>$1800</strong></td>
</tr>
</tbody>
</table>

**Direct Cost Subtotal** $430.00  
**Indirect Cost Subtotal** $0.00  
**Total** $430.00
Appendix B

Definition of Term

- **Obesity** a condition that is characterized by excessive accumulation and storage of fat in the body and that in an adult is typically indicated by a body mass index of 30 or greater ("Obesity", 2017).

- **Multimodal** relating to, having, or utilizing more than one mode or modality that includes stimulation or treatment ("Multimodal", 2017).

- **Bariatric** is a branch of medicine that deals with the treatment of obesity ("Bariatric", 2017).

- **Gastric sleeve** a surgical procedure that typically involves reducing the size of the stomach by surgical removal of a substantial portion of the stomach along the greater curvature. The result is a sleeve or tube-like structure. This helps to restrict food intake and reduce caloric absorption in cases of severe obesity ("Gastric sleeve", 2017).

- **Obstructive sleep apnea** is recurring interruption of breathing during sleep due to obstruction usually of the upper airway especially by weak, redundant, or malformed pharyngeal tissues, that occurs chiefly in overweight middle-aged and elderly individuals, and that results in hypoxemia and frequent arousals during the night and in excessive sleepiness during the day ("Obstructive sleep apnea", 2017).
## Appendix C

### Evidence Table

<table>
<thead>
<tr>
<th>First author, Year, Title, Journal</th>
<th>Purpose</th>
<th>Research Design¹, Evidence Level²</th>
<th>Sample &amp; Sampling, Setting</th>
<th>Measures &amp; Reliability (if reported)</th>
<th>Results &amp; Analysis</th>
<th>Limitations &amp; Usefulness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malczak, 2017 Enhanced recovery after bariatric surgery (ERAS): SR and meta-analysis Obesity Surgery</td>
<td>Evaluate the current literature on ERAS in obesity surgery</td>
<td>Qualitative Meta-analysis, Level 1</td>
<td>Thorough evaluation of 11 articles out of 1151 articles were done.</td>
<td>The Jadad scale was used for quality assessment of the RCTs. Observational studies were evaluated by the Newcastle-Ottawa Scale (NOS). The study risk of bias was assessed by Egger’s regression test. The statistical analysis was performed using RevMan 5.3. Statistical heterogeneity and inconsistency were measured using Cochrane’s Q tests and I². The study was conducted according to the Preferred Reporting Items for Systematic reviews (PRISMA) guidelines and MOOSE consensus statement</td>
<td>The meta-analysis of the length of stay showed a significant reduction standard mean difference = -2.39 (-3.89, -0.89), p=0.002. The analysis of overall morbidity, complications and Clavien-Dindo classification showed no significant variations among study groups</td>
<td>Evaluate the primary outcomes like length of hospital stay, the secondary outcomes included overall morbidity, specific complications, mortality, readmissions and costs</td>
</tr>
<tr>
<td>Gupta, 2014 Retrospective pharmac</td>
<td>To study the perioperative</td>
<td>Retrospective cohort study</td>
<td>Retrospective cohort study of all patients undergone</td>
<td>Evaluated the cost of IV acetaminophen / patient, cost of other</td>
<td>Group was compared with Chi squared test and p-values were reported</td>
<td>IV acetaminophen increased the cost of</td>
</tr>
</tbody>
</table>
### Multimodal Analgesia in Acute Pain Management

| Use of IV acetaminophen and potentia l for cost effectiveness when used in the surgery. | Evidence level | Surgery at Drexel University from September 2011 to February 2012. | Analgesics, Used the VAS, length of stay, global patient satisfaction, and opioid related side effects | 80% received a combination of analgesics intraoperatively, 36% did not receive post-operative analgesic, and 19% had regional anesthetic nerve block. 88% did not have any adverse events, 6.25% has post-operative nausea and 1.25% had vomiting. 88% did not have any adverse events, 6.25% has post-operative nausea and 1.25% had vomiting. | Needs for randomized controlled studies to delineate the role and cost effectiveness of MMA and IV acetaminophen. |

<table>
<thead>
<tr>
<th><strong>Bariatric surgery and opioid related adverse events</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sullivan, 2016</strong></td>
</tr>
</tbody>
</table>

Acetaminophen may be considered a first-line analgesic in trauma. NSAIDS can be useful in low dose and help in patients with nausea. Alpha-2 adrenergic agonists are opioid sparing analgesics that provide sedation and anxiolytic. Nonpharmacological approaches may complement drug therapy as part of a multimodal plan. They are easy to implement and safe. None of the studies were double blinded.

To investigate whether multimodal analgesia reduces narcotic consumption and may have an influence on opioid-related side effects in patients undergoing laparoscopic Roux-en-Y gastric bypass surgery

Quantitative retrospective data analysis Level 3

181 patients were reviewed. 89 patients received hydromorphone PCA and the next 92 patients received IV acetaminophen (APAP) and IV Ketorolac every 6hrs for the first 24 hrs. 8 patients were excluded from the study.

Measure the relative risk of opioids like nausea and vomiting

Patients with PCA required 4.2mg hydromorphone in the postoperative period while the patients in the non-opioid group required 1.1mg of hydromorphone, which is a 73.8% reduction of opioids. The requirement of an antiemetic was also decreased in the non-opioid group.

Maund, 2011 Paracetamol and selective and non-selective non-steroidal anti-inflammatory drugs for the reduction in morphine-related side effects after major surgery: a

To determine which class of non-opioid analgesic, paracetamol, NSAID S or COX-2 inhibitors is the most effective in reducing morphine consumption

SR and MTC analysis Evidence Level 2

Sixty studies were identified from MEDLINE, EMBASE and Cochrane Central Register of Controlled Trials

MTC analysis using a Bayesian Markov chain Monte Carlo simulation and Win BUGS software to obtain relative effects and probabilities A modified Jadad scale was used to assess study quality

The MTC found that when paracetamol, NSAIDS or COX-2 inhibitors when added to PCA morphine had a significant reduction in morphine consumption. Paracetamol [mean difference(MD) - 6.34mg; 95% credibility interval (Crl) -9.02, -3.65], NSAIDS (MD - 10.18; 95% CrI -11.65, -8.72), and COX-2 inhibitors (MD -10.92, 95% CrI -12.77, -9.08) There was significant reduction in nausea and vomiting

Use of IV paracetamol and COX-2 inhibitor in major surgery for pain control and prevent nausea and vomiting
systemic review
British Journal of Anesthes
systemic review and morphine related adverse effects.

Acetaminophen and or Dexmedetomidine in Peri-Operative Pain management

McNicol, 2016
Single dose intravenous paracetamol or intravenous propacetamol for postoperative pain. Cochrane Database SR

To assess the efficacy and safety of IV formulations of paracetamol for the treatment of postoperative pain in both adults and children

Randomized, double-blind, placebo-or active-controlled single dose clinical trials of IV paracetamol or IV propacetamol for acute postoperative pain in adults or children.

Evidence level 1

The Cochrane Central Register of Controlled Trials (CENTRAL, 2016, Issue1), MEDLINE (May 2010 to February 2016), EMBASE (May 2010 to February 2016), LILACS (2010 to 2016), a clinical trials registry, and reference lists of reviews for randomized control trials (RCTs) in any language were reviewed

Two review authors independently extracted data, which included demographic variables, type of surgery, interventions, efficacy and adverse events. Included studies were graded for methodological quality by assessing risk of bias and employed the GRADE approach to assess the quality of evidence

75 studies were included enrolling a total of 7200 participants. 36% participants receiving IV paracetamol/propacetamol experienced at least 50% pain relief over four hours compared with 16% of those receiving placebo. Participants receiving IV paracetamol required 26% less opioids over four hours. Adverse events occurred at similar rates in both the groups.

Iv Paracetamol/propacetamol provides around four hours of effective analgesia for 36% of patients with acute postoperative pain.

Booth, 2016
A randomized controlled trial comparing two multimodal analgesic techniques

To determine if the addition of systemic acetaminophen and an increased dose of

Qualitative randomized controlled trial comparing two multimodal analgesic techniques

Level 2

scheduled for elective C-section were enrolled. Pts in the intervention group got 300mcg of morphine in the spinal and 1gm of Acetaminop

At 24 hrs. patients pain scores related to movement, rest, on average and worst pain were documented using a VAS. Persistent pain and depression assessed at 8

Adding a higher dose of spinal morphine combined with systemic acetaminophen to patients predicted to have severe postoperative pain had significantly lower pain scores. There was no difference in the persistent pain or depression in both the groups.

Adding non-opioid drug like IVAPAP has significant benefit in providing pain relief.

The study would have been more reliable if the...
| Salama, 2016 | Multimodal analgesia with pregabalin and dexmedetomidine in morbidly obese patients undergoing laparoscopic sleeve gastrectomy: A prospective randomized double-blind placebo controlled study | Evaluating the effects of combining dexmedetomidine infusion and oral pregabalin on supplemental opioid requirement, pain score and hemodynamic parameters during the first 24 hrs. in bariatric surgery. | Quantitatively double blinded, randomized, controlled trial | Exclusion and inclusion criteria set up. Random selection using computer generated randomization numbers. Group A n=30 received 75mg oral pregabalin and Group B N =30 received placebo capsule. Intraoperatively Group A received Dexmedetomidine infusion 0.4mcg/kg/hr. after a bolus 0.5mcg/kg, Group B received bolus saline | Sedation assessed by Ramsay sedation score Nausea levels assessed using 11-point verbal rating scale Pain evaluated by VAS No difference in patient demographics in both groups. Operative time was also same | Data were coded using statistical package. Comparison between groups done by using unpaired test. Chi square test was performed | The heart rate, mean arterial BP, pain score, intraoperative fentanyl, post-operative morphine uses and nausea was decreased in group A than B Sedation was more in Group A than B |
| Lam, 2016 | Multimodal analgesia model to achieve | To determine if adding multimodal analgesia | Qualitative Prospective Observational case series | Thirty consecutive patients scheduled for laparoscopic sleeve | Pain scores were noted, and analgesic given in the post-operative period was also noted | Out of the 30 patients 14 (46.7%) did not require any opioid for rescue analgesic postoperatively. Six (20.0%) required rescue opioids for pain. | With combination of multimodal analgesia with local infiltration it |
| Gamboa, 2016 | To assess the strategies used for pain control in bariatric surgery with a discussion regarding the clinical implications and possible protocols to be used in post anesthesia care unit (PACU) and surgical wards. Aim is to reduce postoperative pain. | Meta-analysis papers, review articles, clinical trials, prospective and retrospective case series were included in the review. Evidence level 5 | N/A | Multimodal approach with specific recommendations grouped by efficacy, safety and availability should be considered for bariatric surgery as it helps to reduce opioid consumption, less nausea/vomiting and lower pain scores. | Bariatric surgery has several issues that demand the use of MMA. Lack of high quality evidence studies to support individual and combined therapies, no multicenter randomized clinical trials and consensuses are focused in pain management in bariatric surgery. |

| low postoperative opioid requirement following bariatric surgery Hong Kong Medical Journal | a would reduce opioid requirement postoperatively | gastrectomy were reviewed. Inclusion and exclusion criteria were set up | is possible to reduce the opioid requirement postoperatively. This was a prospective observational study with relatively small number of patients, as there was no data available on previous protocol this study could not be compared. |  |  |
| Au, 2015 | The Efficacy and clinical safety of various analgesic combinations for post-operative pain after third molar surgery: A systematic review and meta-analysis | Plos One | To assess which analgesic combination and dosage is potentially the most effective and safe for acute post-operative pain control after third molar surgery. | A systematic review and meta-analysis of relevant articles. Three databases used were PubMed, Embase, and Cochrane library form year 1998-2012 Evidence Level 1 | Randomized clinical trial with placebo control. Two were multicenter studies, thirteen were double blinded single oral dose studies and one was double blinded with repeated doses. Fourteen studies with 3521 subjects, with 10 groups of analgesic combination that met the inclusion criteria. | Sum of pain intensity difference in 6 hours post-operatively (SPID6) Four-point pain score was used. Total pain relief in 6 hours (TOTPAR6) after analgesic consumption was also recorded. | Meta-analysis of the data was performed by looking at the heterogeneity of the studies. Cochrane Q and quantification of dispersion between studies using I², values were calculated using Comprehensive Meta-Analysis (version 2.2.064, Englewood, New jersey). The random effects model was chosen, and significance level was set at 0.05. The protocol followed the PRISMA statement (Preferred reporting items for systematic reviews and meta-analysis) and it helps to ensure the clarity and transparency of the reviews. | Analgesic combinations have proven to be more effective in pain control than a single drug. Possibility of reporting bias Nausea was the most common adverse effect in the analgesic combination with an opioid. |

| Ren, 2015 | Determining the use of Dexmedetomidine as an adjunct for pain management | A CONSORT-prospective, randomized, double blinded, controlled trial | Women who underwent total abdominal hysterectomy in one institute during March 2014-July 2014 were enrolled in the study if they met the inclusion criteria. An exclusion criterion was also set up. Patient were educated on. The sample size of 90 was calculated based on an expected difference of 25% in IV sufentanil PCA consumption. The Kolmogorov-Smirnov test was used to assess the distribution of variables. Homogeneity of variance determined using Levene. The group treated with combination of the higher dose of dexmedetomidine and sufentanil had better analgesia and better patient satisfaction, without any increase in frequency of adverse events. | | | | This study proved that combination of sufentanil (0.02mcg/kg/h) and dexmedetomidine 90.05mcg/kg/h) was associated with less PCA requirement, better analgesic effect, and better satisfaction. |
| Controlled Trial Medicine | To determine if IV acetaminophen has the potential to reduce the narcotic requirement post bariatric surgery | Quantitative retrospective review of medical records of patients underwent laparoscopic Roux-en-Y gastric bypass between 2011-2013 Level 3 | Linear regression analysis confirmed the results and they were independent of age, gender and body mass index distribution or DM2 | Study was done in a single center, using a fixed rate was related to hemodynamic instability. The concentration of dexmedetomidine was not measured at any point, the study included a heterogeneous group of patients of age 35-65 years.

Saurabh et al., 2015. Schedule intravenous acetaminophen (APAP) reduces postoperative narcotic analgesic demand and requirement after laparoscopic Roux-en-Y gastric bypass. Surgery for Obesity and Related Diseases: Official Journal of The America 183 patients received acetaminophen in addition to morphine 229 patients received morphine only During the first 24hr the after LRYGB the group that received IV APAP had 25% reduction in opioid use. Linear regression analysis used

Retrospective analysis – cannot control variables Possible inconsistency in the documentation of pain score by different providers The demographic features were similar for both the groups
<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Title</th>
<th>Study Design</th>
<th>Eligibility Criteria</th>
<th>Methodology Quality</th>
<th>Findings</th>
<th>Notes</th>
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<tr>
<td>Anderso n, 2014.</td>
<td>Analgesic treatment in laparoscopic gastric bypass surgery: A systemic review of randomized trials Obesit y surgery.</td>
<td>Investigate analgesic regimen used in laparoscopic Roux-en-Y gastric bypass (LRYGB) surgery</td>
<td>Nine studies met the eligibility criteria for inclusion</td>
<td>N/A</td>
<td>The Oxford quality scoring system scores were used. Found that there is a need for high-quality, procedure-specific analgesic treatment in LRYGB.</td>
<td>The methodology quality of the included studies was limited. None of the studies incorporated multimodal procedure specific analgesic regimen.</td>
</tr>
<tr>
<td>Song, 2014.</td>
<td>Optimizing multimodal analgesia with intravenous acetaminophen and opioids in postoperative bariatric patients. Pharmacotherapy.</td>
<td>To evaluate the effect of IV APAP on postoperative opioids after bariatric surgery</td>
<td>Records of 104 patients who underwent Laparoscopic sleeve gastrectomy (LSG, 44) or laparoscopic Roux-en-Y gastric bypass (LRYGB, 60) patients were reviewed. Patients received 1gm APAP every 6hrs postoperatively (22LSG and 30 LRYGB patients) or no IV APAP (22 LSG patients and 30 LRYGB patients)</td>
<td>Baseline demographic features were similar for both groups.</td>
<td>Patients receiving IV APAP required less IV morphine compared to the opioid only group. IV APAP was associated with shorter hospital length of stay, mean difference control group 1.47 days; p=0.039 multimodal group 0.95 days; p=0.025, pts who received IV APAP had earlier return of bowel sounds and flatus. There was no change in pain scores.</td>
<td>Retrospective analysis – cannot control variables. IV APAP helps to eliminate ORAE’s which provides better outcome and quality care.</td>
</tr>
<tr>
<td>Schnabel, 2013.</td>
<td>Is intraoperative</td>
<td>To assess the efficacy</td>
<td>Twenty-eight randomized controlled</td>
<td>DEX report less postoperative pain intensity and a lower</td>
<td>Patients treated with DEX report less postoperative pain intensity and a lower</td>
<td>The most common adverse event in patients</td>
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<tr>
<td>Ong, 2010 Combining Paracetamol (Acetaminophen) with Nonsteroidal Anti-Inflammatory Drugs: A Qualitative Systematic Review of Analgesic Efficacy for Acute Postoperative Pain</td>
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<td>To assess the effect of a combination of analgesics to provide additive effect with fewer side effects than when a single drug is used</td>
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<td>A broad search was undertaken in Medline, Embase, Cumulative Index to Nursing and Allied Health Literature, and PubMed, from January 1988 to June 2009.</td>
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<td>Trials including 1420 patients investigating perioperative administration of DEX were included</td>
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<td>The preferred reporting items for SR and meta-analysis (PRISMA) and the recommendations for the Cochrane Collaboration</td>
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<td>Opioid consumption compared with placebo. Additionally, the DEX group showed a lower RR for opioid-related adverse events.</td>
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<tr>
<td>Treated with DEX was intraoperative bradycardia. The comparison of DEX vs opioids is less clear due to limited data.</td>
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Mean (SD) reduction in pain intensity was 35.0% (10.9%); the reduction in analgesic supplementation was 38.8% (13.1%). The quality scores of the studies ranged from 2 to 5. The median quality score was 4 for the positive studies and 3 for the negative studies (Mann-Whitney U test: P=0.18). A Mann-Whitney U test was used to assess the relationship between the positive and negative trials and the quality scores. Statistical heterogeneity was evaluated both qualitatively and qualitatively using the funnel plot and Cochran Q test. Combining paracetamol and an NSAID confers additional analgesic efficacy over either drug alone. It was a qualitative approach and the wide range of acute pain models are the limitations. The use of fixed dose reduces flexibility in dose titration.
<table>
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<tr>
<th>Guidelines for post-operative pain management</th>
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<tr>
<td>Gordon, 2016 Research gaps in practice guidelines for acute postoperative pain management in adults: Finding from a review of the evidence for an American Pain Society clinical practice guideline. Journal of pain</td>
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<td>Chou et al, 2015 Management of post-operative pain: A clinical practice guideline from the American Pain Society, the American Society of Regional Anesthesiology and Pain Medicine, and the American Society of Anesthesiologists’ Committee on Regional Anesthesia, Executive Committee, and Administrative Council. Journal of Pain.</td>
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<td>Americaan Society of Anesthesiologists, 2012 Practice guideline for acute pain management in the Perioperative setting: An Update report by the American Society of Anesthesiologists Task Force on acute pain management Anesthesiology</td>
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Appendix D
Theory Application Diagram

Middle Range Theory of Acute Pain Management

<table>
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<tr>
<th>Potent Pain Medication</th>
<th>Pharmacologic Adjuvant</th>
<th>Nonpharmacologic Adjuvant</th>
<th>Balance Between Analgesia and Side Effects</th>
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<td>Attentive Care</td>
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<td>Regular Assessment of Pain &amp; Side Effects</td>
<td>Identification of Inadequate Relief and Unacceptable Side Effects</td>
<td>Intervention, Reassessment, Reintervention</td>
<td>Balance Between Analgesia and Side Effects</td>
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<td>Patient Participation</td>
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<td>Patient Teaching</td>
<td>Goal Setting for Pain Relief</td>
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(Good & Moore, 1996)

Theoretical Model of EBP

Multi-modal interventions

| Potent meds Opioids + Multimodal analgesia (Dexmedetomidine & Acetaminophen) + Nonpharmacological Adjuvant (Music, massage, meditation) + Balance Between Analgesia and Side Effects |
|---|---|---|---|---|
| Attentive Care                        | | | | |
| Pain assessment using VAS Vitals check + Identify pain score more than 4, unstable vitals, Administer pain, anti-nausea meds, early ambulation + | | | | |
Effective pain relief and decreased length of stay

(BP, HR & SPO2)

nausea, vomiting, length of stay

Pre-operative patient education + Goal Setting for Pain Relief

Patient Participation +

(Good & Moore, 1996)
### Appendix E

#### Logic Model for DNP Project

**Student:** Sherly Shaji,

**INQUIRY, PICOTS:** In the adult with bariatric surgery, does evidence-based multimodal analgesia compared to opioids only decrease recovery time as measured by length of stay in the hospital and acute pain over a 3-day period post-operative period at the Dallas Veterans Affairs Hospital?

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<th>Outputs - Activities</th>
<th>Participation</th>
<th>Outcomes -- Impact</th>
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<tr>
<td>Evidence, sub-topics</td>
<td>EBP intervention</td>
<td>The participants</td>
<td>(Completed during DNP Project)</td>
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<tr>
<td>2. Bariatric surgery and opioid related adverse events</td>
<td>Major steps of the intervention</td>
<td>Major Facilitators or Contributors</td>
<td>Outcomes to be measured</td>
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<tr>
<td>3. Use of IV Acetaminophen and or Dex in perioperative Pain management</td>
<td>1. Educating Nurses and patient about MMA and advantages over only opioids 2. Preoperative teaching about attitudes and expectations of pain 3. Appraising the pain and side effects on a regular basis</td>
<td>1. DNP Student 2. DNP Advisor 3. Anesthesiologists/CRNA’s 4. Post anesthesia and intensive care Unit nurses</td>
<td>Secondary, if applies: Amount of opioid consumption postoperatively Nausea/vomiting</td>
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<td>4. Guidelines for post-operative pain management</td>
<td>Major Barriers or Challenges</td>
<td>Major Barriers or Challenges</td>
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<td>1. Verbal analog scale 2. Days in the hospital post operatively</td>
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<td>Statistical analysis to be used</td>
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<td>1. The confidence interval (CI) 2. The Mann Whitney tests</td>
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Appendix F

Project Timeline

- July 2017: IRB Approval
- August 2017: Retrospective chart review
- November 2017: Data collection & analysis of data
- December 2017: Post data analysis Education
- January 2018: Proposal for ERAS Protocol
Appendix G

Intervention Flow Diagram

- **Consent**
  - August 2017 - Sept 2017
  - Obtaining Approval from IRB

- **Pre-Data Recruit**
  - Oct 2017
  - Pre-Data collection
  - Identify the patients
  - Inclusion & Exclusion criteria

- **Data Collection**
  - Nov 2017
  - Chart review & Collect data

- **Post Data Collection/Analysis**
  - Dec 2017
  - Data Analysis / Statistical Analysis

- **Results**
  - Jan 2018
  - Implementation of findings
  - Dissemination of findings
  - Conclusion and Interventions

- **Future Research**
Appendix H
A Model for Evidence-Based Practice Change
By Rosswurm and Larrabee

Assess the need for change in practice

Locate the best evidence

Integrate and maintain change in practice

Critically analyze the evidence

Implement and evaluate change in Practice

Design practice change

(Larrabee, 2009)
July 12, 2017

Members of Institutional Review Board
Veterans Affairs North Texas Health Care System
Dallas, Texas

IRB Members,

This letter serves to provide documentation regarding Sherly Shaji’s Doctor of Nursing Practice (DNP) Project proposal. Ms. Shaji obtained approval for her project proposal, *Role of Multimodal Analgesia in Recovery and Acute Pain in Bariatric Surgery* from the School of Nursing DNP faculty committee on July 12, 2017.

If I can provide any further information, please feel free to contact me.

Sincerely,

Susan J. Kimble, DNP, RN, ANP-BC, FAANP
Clinical Associate Professor
DNP Programs Director
UMKC School of Nursing and Health Studies
816-235-5962
kimbles@umkc.edu
Appendix J

Numerical Rating Scale (NRS)
Appendix K

Data Collection Template

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<td>▶ Right</td>
<td>Unknown</td>
<td>▶ Input</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>PMorphine</td>
<td>Numeric</td>
<td>B</td>
<td>2</td>
<td>None</td>
<td>None</td>
<td>B</td>
<td>▶ Right</td>
<td>Unknown</td>
<td>▶ Input</td>
<td></td>
</tr>
</tbody>
</table>
Appendix L
Statistical Analysis Results Tables

Table 1. Summary Statistics of Patient BMI

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Median</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opioids Only</td>
<td>40.95</td>
<td>41.00</td>
<td>4.96</td>
<td>29.84</td>
<td>53.81</td>
</tr>
<tr>
<td>MMA</td>
<td>41.59</td>
<td>41.56</td>
<td>4.82</td>
<td>31.02</td>
<td>54.12</td>
</tr>
</tbody>
</table>

Table 2. Summary Statistics of Patient Age

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Median</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opioids Only</td>
<td>54.38</td>
<td>57.00</td>
<td>11.51</td>
<td>30.00</td>
<td>72.00</td>
</tr>
<tr>
<td>MMA</td>
<td>50.54</td>
<td>50.00</td>
<td>11.24</td>
<td>27.00</td>
<td>74.00</td>
</tr>
</tbody>
</table>
Table 3. Frequency Distribution of Patient Gender

<table>
<thead>
<tr>
<th>Group</th>
<th>Gender</th>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opioids</td>
<td>Only</td>
<td>Count</td>
<td>17</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% Within Opioids</td>
<td>36.2%</td>
<td>63.8%</td>
</tr>
<tr>
<td>MMA</td>
<td>Count</td>
<td>22</td>
<td>30</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>% Within MMA</td>
<td>42.3%</td>
<td>57.7%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Table 4. Frequency Distribution of Patient ASA

<table>
<thead>
<tr>
<th>Group</th>
<th>ASA</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opioids</td>
<td>Only</td>
<td>Count</td>
<td>1</td>
<td>46</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>% Within Opioids</td>
<td>2.1%</td>
<td>97.9%</td>
<td>0.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>MMA</td>
<td>Count</td>
<td>0</td>
<td>51</td>
<td>1</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>% Within MMA</td>
<td>0.0%</td>
<td>98.1%</td>
<td>1.9%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
### Table 5. Frequency Distribution of Patient Tobacco Use

<table>
<thead>
<tr>
<th>Group</th>
<th>Tobacco</th>
<th>Count</th>
<th>Never</th>
<th>Quit</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Current</td>
<td>0</td>
<td>20</td>
<td>27</td>
<td>47</td>
</tr>
<tr>
<td>Opioids Only</td>
<td>% Within</td>
<td>0.0%</td>
<td>42.6%</td>
<td>57.4%</td>
<td>100.0%</td>
</tr>
<tr>
<td>MMA</td>
<td>Count</td>
<td>1</td>
<td>32</td>
<td>19</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>% Within MMA</td>
<td>1.9%</td>
<td>61.5%</td>
<td>36.5%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

### Table 6. Summary Statistics of Length of Surgery

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Median</th>
<th>Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opioids Only</td>
<td>117.00</td>
<td>104.00</td>
<td>42.30</td>
<td>51.00</td>
<td>250.00</td>
</tr>
<tr>
<td>MMA</td>
<td>114.98</td>
<td>104.50</td>
<td>48.35</td>
<td>48.00</td>
<td>274.00</td>
</tr>
</tbody>
</table>
Table 7. Summary Statistics for Study Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Group</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Stay (Hours)</td>
<td>Opioids Only</td>
<td>56.32</td>
<td>47.32</td>
<td>31.72</td>
<td>14.00</td>
<td>164.29</td>
</tr>
<tr>
<td></td>
<td>MMA</td>
<td>53.05</td>
<td>46.21</td>
<td>38.32</td>
<td>22.20</td>
<td>242.16</td>
</tr>
<tr>
<td>Intra-Operative Morphine Equivalent</td>
<td>Opioids Only</td>
<td>4165.12</td>
<td>3723.17</td>
<td>1937.36</td>
<td>1540.23</td>
<td>10384.00</td>
</tr>
<tr>
<td></td>
<td>MMA</td>
<td>3955.10</td>
<td>3363.15</td>
<td>2412.25</td>
<td>1672.03</td>
<td>15826.83</td>
</tr>
<tr>
<td>Post-Operative Morphine Equivalent</td>
<td>Opioids Only</td>
<td>20.14</td>
<td>15.33</td>
<td>15.89</td>
<td>2.67</td>
<td>72.67</td>
</tr>
<tr>
<td></td>
<td>MMA</td>
<td>21.74</td>
<td>16.67</td>
<td>24.04</td>
<td>0.00</td>
<td>120.00</td>
</tr>
</tbody>
</table>
Figure 1. Histograms of Length of Stay

a) Opioids Only

b) MMA
Figure 2. Histograms of Intra-Operative Morphine Equivalent

- a) Opioids Only
- b) MMA
Figure 3. Histograms of Post-Operative Morphine Equivalent

a) Opioid only

b) MMA
Table 8. Results of Mann-Whitney Tests

<table>
<thead>
<tr>
<th>Measure</th>
<th>Z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Stay (Hours)</td>
<td>-0.86</td>
<td>0.39</td>
</tr>
<tr>
<td>Intra-Operative Morphine Equivalent</td>
<td>-1.03</td>
<td>0.30</td>
</tr>
<tr>
<td>Post-Operative Morphine Equivalent</td>
<td>-0.10</td>
<td>0.92</td>
</tr>
</tbody>
</table>

Figure 4. Bar Chart of Median Length of Stay by Group
Figure 5. Bar Chart of Median Intra-Operative Morphine Equivalent by Group

Figure 6. Bar Chart of Median Post-Operative Morphine Equivalent by Group