Multimodal Opioid Sparing Anesthesia for Women Undergoing Robotic-Assisted Laparoscopic Hysterectomy

Doug J. Ombongi

Submitted in partial fulfillment of the requirement for the degree of

Doctor of Nursing Practice

Bloomsburg University

Department of Nursing

Project Manager: Debbie Minzola, Ph.D., CRNA

Clinical Expert: Thomas Eckert, MD

Date of Submission: April 30, 2021

Table of Contents

Abstract

Background: The opioid overdose epidemic is a public health crisis in the United States. According to the Centers for Disease Control and Prevention (CDC, 2019), in 2017, there were over 70,000 overdose deaths, of which more than 47,000 involved opioids. Opioid-related deaths have led to a decline in life expectancy and have become the leading cause of unintentional death. A patient's first exposure to opioids may be during the perioperative period. Anesthesia providers are equipped to decrease or eliminate the use of opioids by utilizing multimodal analgesia (Koepke et al., 2018).

Purpose: Patients who received multimodal therapy were three times more likely to decline opioids without any concomitant increase in pain compared to an opioid-only cohort following laparoscopic hysterectomy (White et al., 2019). The purpose of this project was to implement an evidence-based protocol in multimodal anesthesia to spare the amount of opioids administered during the performance of robotic-assisted laparoscopic hysterectomies at a local hospital.

Methods: Following IRB approval, all relevant perioperative staff was educated about multimodal opiate sparing techniques, pain assessment, and implementing the project. Patients were informed and consented. A Multimodal Opioid Sparing Anesthetic (MOSA) technique was utilized. If opioids were administered, they were converted to morphine dose equivalents (MMEs) for ease of comparison. Before the operation and upon arrival to the Post Anesthesia Care Area (PACU), pain scores were recorded.

Keywords: multimodal anesthesia, opioid-free anesthesia, robotic hysterectomy, enhanced recovery, opioid epidemic

Multimodal Opioid Free Anesthesia for Women Undergoing Robotic-Assisted Laparoscopic Hysterectomy

Chapter I: Introduction

Background and Significance

Narcotics have been used for over thirty years to provide balanced anesthesia. Opioids are administered to decrease sympathetic system activation, treat surgical pain, and deter systemic inflammatory activation (Beloeil et al., 2018). Although Zhao et al. (2019) argued that the effectiveness and convenience of administering narcotics had decreased the incentive to incorporate other alternatives to treat pain, the use of opioids is not without risk. About two million Americans have an opioid use disorder, and recent data suggests that one person dies every fifteen minutes from an opioid overdose, making opioids the leading cause of accidental death in the United States (Bonnie et al., 2017; Rudd et al., 2016; Schuchat et al., 2017).

When Friedrich Sertürner discovered morphine in 1804, the four human subjects it was tested on almost died from an overdose, demonstrating its potency and narrow therapeutic window. Morphine's efficacy as a painkiller was so overwhelming that it became the gold standard for developing synthetic opioids such as fentanyl (Luch, 2009). Narcotics are a primary component of most anesthetics, but the increased risk of abuse and addiction has led some to question their utility as the sole agents for perioperative analgesia (Neuman et al., 2019).

In 2001, the Joint Commission campaigned for treating pain as a fifth vital sign. The renewed emphasis on pain increased focus on pain assessment and treatment, resulting in a significant increase in opioid administration and their associated untoward effects (National Institute on Drug Abuse [NIDA], 2009). In 2013, the economic burden of the opioid crisis resulting from lost productivity, associated criminal justice costs, and healthcare and rehabilitation costs was approximately $80 billion (Florence et al., 2016).

Pharmaceutical companies aggressively marketed narcotics, especially oxycontin, to increase sales and boost profits. Reassurances discounting the addictive potential of opioids increased opioid prescriptions. These two events – increased surveillance and aggressive marketing - synergistically promoted over-treatment of pain, indiscriminate prescribing, misuse, and diversion leading to addiction and death. In 2017, over 47,000 Americans died from an opioid overdose (NIDA, 2009).

In 2018, approximately 184 people died daily in the United States from an opioid overdose. The opioids implicated include fentanyl, prescription opiates, and heroin. Although the age-adjusted rate of overdose deaths decreased by 4.6% from 2017 to 2018, it remains a national emergency, with rates as high as five times what they were in the 1990s (Hedegaard et al., 2020). Unfortunately, according to Cicero and Ellis (2017), no *opioid* has been developed with *opiate* equipotency without the abuse potential of *opium* despite many years of research.

Beauchamp et al. (2014) estimated that up to 40% of all patients exposed to opiates develop some form of physical dependence and addiction. Approximately 51 million individuals undergo surgery annually. Irrespective of their prior opiate use, up to 80% of opiate naïve patients receive narcotics for low-risk surgery intraoperatively (Hah et al., 2017).

The practice of anesthesia has been positively impacted by advances in technology for general and regional anesthesia. Minimally invasive surgical techniques, such as robotic hysterectomy, have made it possible to decrease reliance on opioids during surgery due to less painful smaller incisions (Pyati et al., 2018; Sinha et al., 2019).

Multimodal methodologies target different receptors to achieve a superior synergistic reduction in pain, leading to better pain control. Research has shown this method provides a reduction in pain compared to opioid monotherapy. In addition to regional anesthesia (neuraxial and peripheral nerve blocks such as the transverse abdominis plane), many other medications have proven to support the opioid-sparing anesthetic technique. Drugs such as acetaminophen, gabapentin/pregabalin, ketamine, magnesium, dexamethasone, non-steroidals (NSAIDs), lidocaine, esmolol, dexmedetomidine, and duloxetine are essential components of an opioid-sparing (or opioid-free) anesthetic technique (Koepke et al., 2018).

A hysterectomy is a standard surgical procedure for women, second only to cesarean section. The American College of Obstetricians and Gynecologists (2015) estimates that over 2000 centers perform robotic surgeries, with an expected growth rate of 25% annually. In one northeast hospital, the average caseload is eight cases a week for various indications, including endometriosis and various cancers.

Implementing an opioid-sparing multimodal protocol during robotic-assisted laparoscopic hysterectomies standardized the protocol for pain management perioperatively. It improved the reported pain scores, decreased the amount of opioids administered, and begun to shift the perioperative staff's attitudes regarding narcotics as the primary treatment for post-surgical pain. The utilization of fewer opioids intraoperatively will decrease opioid prescriptions, incidents of persistent use, and opioid diversion in the community (Koepke et al., 2018).

Problem Statement

The use of opioids intraoperatively as the monotherapy for pain management leads to an increased need for opioids postoperatively to achieve the desired self-reported pain level. The increased need arises from the development of acute opioid tolerance and the development of opioid-induced hyperalgesia. Although the extent of either phenomenon is unknown, the result is an increase in the number of opioids required over time to achieve analgesia (Bekhit, 2010).

According to Joly et al. (2005), this opioid paradox is common in patients receiving remifentanil and can persist for up to 48 hours postoperatively. Receptor theory suggests that initial desensitization followed by an up-regulation of opioid receptors leads to dose escalation, chronic tolerance, and dependence (Zuo, 2005).

The site for this quality improvement (QI) project was a midsize hospital in northeast Pennsylvania. The current practice for robotic hysterectomy surgery did not have a standardized multimodal protocol, resulting in the primary use of opioids for pain. The gap identified became the basis for this project. Multimodal techniques emphasize preventative analgesia and decrease the amount of opioids (in terms of morphine milligram equivalents, MMEs) administered by promoting optimal analgesia. Optimal analgesia may decrease opioid over-prescription, resulting in decreased unused opioids - a source of opioid diversion and abuse (Bicket et al., 2017).

The PICO question guiding this project was: Will multimodal opioid-sparing anesthesia (MOSA) for women aged 18-65 undergoing robotic-assisted laparoscopic hysterectomy provide optimal analgesia compared to an opioid only cohort? (See Appendix A for the conversion factors for computing MMEs). The perioperative department's standing orders defined optimal analgesia as a pain score $\leq 4/10$, which is used among other criteria to discharge patients from PACU.

Definition of Terms

The following theoretical definitions guided this QI project:

Acute pain: the normal, predicted, physiologic response to adverse stimuli resolves within one month (Macres et al., 2017).

Addiction: a biopsychosocial disease characterized by dysfunctional behavior that involves a craving, compulsive use, loss of control, and the continued of a drug despite adverse consequences (Macres et al., 2017).

Chronic pain: pain without apparent biologic value that has persisted beyond the normal tissue healing time of about three months and often affects an individual's well-being or function (Macres et al., 2017).

Cross-tolerance: tolerance to other opioids following the use of one opioid, but the degree to which this happens varies widely and is often incomplete, thereby allowing clinicians to use opioid rotation to restore analgesic sensitivity (Macres et al., 2017).

Enhanced Recovery After Surgery (ERAS) pathway: a multidisciplinary initiative pioneered in Denmark by Kehlet in 1997 that decreases perioperative opioid utilization through multifaceted techniques to deliver optimal analgesia, minimize complications, and accelerates discharge (Koepke et al., 2018).

General anesthesia: a drug-induced reversible state of unconsciousness, amnesia, analgesia, immobility, and attenuation of autonomic responses to noxious stimuli in an intact organism (Crowder et al., 2017).

Multimodal analgesia: simultaneously disrupting nociceptive information processing using antinociceptive agents that act on multiple nociceptors, neurotransmitters, or neural relays in the ascending and descending nociceptor pathways (Brown et al., 2018).

Opioid-induced hyperalgesia (OIH): a state of nociceptive sensitization during or following escalating opioid treatment. It can also occur postoperatively following the infusion of remifentanil during anesthesia. Ketamine, an *N*-methyl-D-aspartate (NMDA) receptor antagonist, can treat or prevent it (Dahan et al., 2017).

Opioid receptor: a specific site where an opioid exerts its action, the most important being the μ-opioid receptor, δ-opioid receptor, and the κ-opioid receptor (Dahan, 2017).

Opioid paradox: the more opioids are used intraoperatively, the more opioids are required postoperatively to treat pain (Koepke et al., 2018).

Optimal analgesia: Optimizing patient comfort and facilitating the recovery of physical function while minimizing the adverse effects of analgesics, not "pain-free" (McEvoy et al., 2017).

Physical dependence: a physiologic state of adaptation to a specific psychoactive substance characterized by the emergence of a withdrawal syndrome during abstinence, which may be relieved in total or in part by the substance's re-administration (Macres et al., 2017).

Preventive analgesia: any antinociceptive regimen delivered at any time during the perioperative period that will attenuate pain-induced sensitization to block the development of sustained pain (Macres et al., 2017).

Robotic-assisted laparoscopic hysterectomy: surgical removal of the uterus with the assistance of a surgical robot by creating a pneumoperitoneum, insertion of a video laparoscope, and trocars (Rodriguez & Sharma, 2017).

Tolerance: an innate or acquired rightward shift of the dose-response curve whereby an increased dosage of a psychoactive substance is required to produce the desired effect (Macres et al., 2017).

Transversus Abdominis Plane (TAP) block: injection of local anesthetic between the fascial layers of the posterior rectus sheath and the rectus abdominis muscles (triangle of Petit) to impede innervation of the abdominal wall up to the level of T8 (Tsui & Rosenquist, 2017).

Project Goals and Objectives

Pain is often associated with surgery, and anesthesia providers manage and treat pain during the perioperative period. Brummett et al. (2017) found that approximately 6% of adult surgical patients were afflicted with new persistent opioid use compared to 0.4% in a non-operative cohort. According to Koepke et al. (2018), opioid use perioperatively begets opioid use postoperatively, leading to opioid over-prescription in all surgical specialties. Forty-one-percent to 71% of all opioid tablets goes unused, becoming an essential diversion and abuse source (Bicket et al., 2017; Chen et al., 2018).

The inclusion of multimodal therapies as part of a preventative analgesia protocol will decrease the amount of opioid utilization perioperatively without adversely affecting the patient experience, as evidenced by the self-reported pain scores. The goals and objectives of this project are:

1. Educate patients about pain and the differentiation between somatic and visceral pain, following a robotic hysterectomy by emphasizing optimal analgesia as part of a Certified Registered Nurse Anesthetist's (CRNA) assessment before sedating a patient.
2. Adopt a standardized protocol for MOSA to be utilized perioperatively to enhance recovery after surgery (ERAS). See Appendix B for the agents to be administered.
3. Decrease the amount of opioids administered perioperatively without adversely affecting patient comfort as evidenced by reported pain upon arrival in PACU.

4. Evaluate the above changes' effectiveness through a chart review by calculating MMEs and self-reported pain scores upon arrival in PACU and at discharge from PACU.

Translating the current research findings to practice is an expectation of advanced practice nurses, and it forms the basis for this QI project. Utilizing MOSA can decrease the administration of opioids for treating acute pain, and therefore benefit society.

Interdisciplinary collaboration is required to evaluate and share information to improve the quality of patient care. Advanced practice nurses can act as change agents to improve health systems using analytical tools, advocacy, and effective leadership skills (Milstead, 2016). This QI project highlights the fundamental qualities of doctoral nursing education, which encourages scientific inquiry into current practice issues to improve the quality of care of a target population, using data and technology outlined by the American Association of Colleges of Nursing Essentials (2006).

Leadership skills and emotional competence were crucial when implementing this project. Adequate preparation and flexibility of the project leader helped overcome the lack of early enthusiasm in the project. Therefore, appealing one's higher ideals beyond the change at hand, like their contribution to an addiction-free society or the cost savings that can be achieved, led to the enthusiastic participation of many and ultimately led to the success of this project as noted by Porter-O'Grady and Malloch (2018).

Lal (2019) argued that to lead through change, it is not sufficient for a leader to just articulate new goals; it is essential to inspire others to commit to achieving those goals. Inspiration requires the leader to appeal to hearts and minds, in essence, defining the "what" and the "why" of the project. Transformational leadership skills guided project implementation without alienating those who were not receptive.

To promoted acceptance, building a team of supporters was important for the success of this QI project. The enthusiasm, energy, and eloquence of the project leader facilitated the conversion of non-supporters into supporters. If you gain their support, those opposed to the change will likely follow while increasing their satisfaction (Moran et al., 2017; Alzahrani & Hasan, 2019).

This chapter explored the background and significance of opioid use in anesthesia and the possibility of incorporating MOSA during robotic hysterectomies. Chapter 2 will include a detailed literature review and the conceptual and theoretical framework that guided this QI project.

Chapter II: Review of Literature

Background information related to multimodal anesthesia, mitigation of the opioid crisis, and opioid-free anesthesia were examined. The pertinent literature showed the importance of ERAS pathways in decreasing opioid consumption and improving patient outcomes. A more in-depth exploration was completed to discover newer guidelines for delivering opioid-sparing anesthesia techniques in robotic-assisted laparoscopic hysterectomies.

Methodology

A computerized systematic literature search was conducted through the Bloomsburg University library portal to identify, appraise, select, and synthesize all high-quality research evidence relevant to MOSA techniques to focus on women undergoing robotic hysterectomies. All the electronic databases publicly available to students were utilized, including Academic Search Premier (EBSCOhost), PubMed, Medline, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane, Google scholar, and Ovid.

The keywords used in the searches were “multimodal anesthesia,” “opioid-free anesthesia,” “robotic hysterectomy,” “enhanced recovery,” and “opioid epidemic.” Boolean operators of “and,” “or” and “not” were also used to identify differences in results yielded. Medical Subject Headings (MSHs) terms used included “anesthesia” and “adjuvants.” The keywords and MSHs yielded over 43,000 articles. The search results were refined and limited to the English language, full text, scholarly and peer-reviewed journals published from 2000 to 2020. A rapid critical appraisal (RCA) on validity, reliability, and applicability was conducted (Melynk & Fineout-Overholt, 2019). The RCA yielded over 100 articles. The articles were further evaluated using a literature review matrix on their strength of scientific evidence to determine appropriateness for inclusion. Evidence summaries and experimental research studies took precedence over non-experimental studies and expert opinions. The references of the selected articles were examined for additional background information. Following a detailed appraisal that focused on methodologies utilized, strengths, and weaknesses, 15 articles were identified to apply to the research question.

Findings

The literature reviewed presented three themes that guided this project – patient-centered, provider-centered, and system-centered. The first theme to emerge was the importance of the perioperative period as a source of high opioid use due to over-treatment of pain (*provider*). The second theme to emerge was acute opioid tolerance and opioid-induced hyperalgesia (*patient*) phenomena arising from opioid monotherapy. Lastly, ERAS pathways (*system*), including patient/provider education, benefit patients, society, and health systems. White et al. (2019) found that patients who participated in a multimodal cohort had the lowest amount of opioid usage (22.5mg versus 55.0 mg) perioperatively without a significant increase in their pain, and as such, had fewer incidences of PONV, early resumption of ADLs, and early discharge. One editorial offered a cautionary tale from a patient who was undertreated for pain in the guise of using an opiate sparing protocol (Moore, 2018).

Persistent Opioid Use. Swenson et al. (2018) conducted a retrospective study on 24,331 women who had a hysterectomy between 2011 and 2014. The inclusion criteria were women under 64 years at the time of the hysterectomy, no opioid prescription refills for eight months preceding, and no additional surgery within six months of the hysterectomy. The perioperative period was defined as 30 days before 14 days after hysterectomy, while persistent opioid use was defined as ≥2 opioid refills within six months of a hysterectomy with ≥1 refills every three months and either total oral morphine equivalents (MME) ≥1150 or days supplied ≥39. A hierarchical logistic regression model controlling for regional variation was utilized to determine factors associated with persistent opioid use following surgery. Bivariate analyses were used to compare persistent with non-persistent users and found that women with new persistent opioid use were older (age ≥ 50; n = 41.8). A higher proportion was African-America (n = 22.31). The education level and geographical location were similar between the two groups. Although the prevalence of new persistent opioid use was found to be low at 0.5% (n=122), their median perioperative MME use was found to be 437.5 mg compared to 225 mg for the non-persistent users. This study identified increasing age, gynecological malignancy, abdominal route, race, depression/anxiety, and preoperative opioid refill as independently associated with new persistent opioid use. Opportunities for improvement based on this study's modifiable factors included an abdominal route for surgery and preoperative opioid prescription.

Tabler (2016) postulated that although opioids are effective agents to treat pain, over-reliance on mono-opioid therapies leads to poor medical outcomes, including increase risk of side effects, prolonged length of stay (LOS), reduced patient satisfaction scores, increased costs of operation, supplies, and liability costs. Further, Gaunt et al. (2014) found that only 8.9 percent of opioid prescribers correctly answered 11 basic questions about opioids, and only 37% knew that opioids cause respiratory depression. Herzig et al. (2013) found that the LOS increased by 10.3% for patients who had opioid-related adverse effects, especially those receiving higher doses or those prescribed before surgery.

Additionally, overreliance on opioids decreased patient satisfaction scores because opioid side effects tend to be painful and unpleasant. It was also observed that the fear of clinicians overprescribing opioids led to under-prescribing resulting in under-treatment of pain, which adversely affected patient satisfaction scores. There are efforts underway by the Centers for

Medicare & Medicaid Services (CMS) to remove pain management scores from payment matrices while retaining the question as part of the satisfaction survey (Gupta et al., 2009).

Acute Opioid Tolerance and Opioid-Induced Hyperalgesia. Colvin et al. (2013) identified opioid tolerance and hyperalgesia as contributors to dose escalation and poor pain management. These two phenomena are troubling because they involve μ receptor signaling, essentially rendering higher doses of opioids less effective while increasing the risk of adverse effects, physical dependence, and addiction. One approach to eliminate this problem is to administer peripheral nerve blockade and multimodal agents such as ketamine, which target alternative pain transmission pathways.

Brown et al. (2018) presented a rational design and practice strategy for implementing a multimodal general anesthetic. The strategy depended on the multiple neurotransmitters and neural relays involved in the ascending and descending pain pathways. The strategy targeted various receptors at which antinociceptive agents disrupted pain transmission. The design achieved the three goals on anesthesia – antinociception, amnesia, and immobility utilizing multimodal agents. The multimodal agents included *N*-methyl-D-aspartate (NMDA) antagonists, some opioid agonists, α-2 agonists, sodium channel blockers (amide local anesthetic), non-steroidal anti-inflammatory drugs (NSAIDs), paralytics, smooth muscle relaxants, and hypnotics.

The respective agents were ketamine, fentanyl, dexmedetomidine and clonidine, lidocaine, ketorolac, vecuronium, magnesium, and propofol. Liposomal bupivacaine was used to provide regional anesthesia via a TAP block.

ERAS Pathways. Henrik Kehlet first proposed the ERAS pathway in 1995 to improve outcomes for patients undergoing colonic surgery. The pathways have been adopted widely into other surgical disciplines such as gynecology and supportive professions such as anesthesia

(Kehlet, 2003). ERAS pathways offered many benefits, including reducing surgical stress, decreased length of stay, superior pain relief, and decreased administration of opioids.

Wijk et al. (2019) conducted an international multicenter cohort study of patients undergoing elective gynecologic surgery for malignant and benign conditions between 2011 and 2017 to evaluate the association between compliance with ERAS Gynecologic/Oncology guideline elements and postoperative outcomes. The subject composition included a median age of 56 years, 35.5% obese, 15% smokers, and 26.7% American Society of Anesthesiologists Class III-IV. Surgical complexity was stratified from medium to high risk using the Aletti scoring system. Covariates including age, body mass index (BMI), and smoking status were accounted for during analysis. The primary end-points were hospital length of stay and complications. Negative binomial regression was used for modeling length of stay and logistic regression to model complications. Laparotomy was used in 75.9% of cases. In patients with ovarian cancer, the median length of stay was two days in the low- and five-day medium/high-complexity group.

Every unit increase in ERAS guideline score was associated with an 8% decrease in hospital days among low-complexity and a 12% decrease among patients with medium/high-complexity scores. For every unit increase in ERAS guideline score, the odds of total complications were estimated to be 12% lower ($P<.05$) among low-complexity patients. Improved compliance with ERAS guidelines is associated with improved clinical outcomes, including the length of stay.

White et al. (2019) conducted a retrospective cohort study of 954 patients who underwent minimally invasive hysterectomy over two years. A control group comprising traditional pain control methods without placement of local anesthetics was compared to an ERAS cohort in terms of length of stay, demographics, opioid dose (MMEs), and pain scores. The ERAS cohort had the lowest opioid usage at 22.5 mg compared to 55.0 mg in the control group. Further, the ERAS group was three times more likely to decline opioid pain medication without a concomitant increase in pain scores. Once again, the ERAS cohort did better postoperatively; however, the study did not have a significant number of minorities for generalizability purposes.

Theoretical and Conceptual Framework

Whereas the theoretical framework provides a general representation of relationships between things in a given phenomenon, the conceptual framework (or research paradigm) embodies the specific direction the research will have to undertake (Kivunja, 2018). This project will utilize Neuman's Systems theory (Appendix D) and the Iowa Model (Appendix E) for a conceptual framework and research paradigm alignment.

Neuman's Systems theory was first proposed in 1970 as a means of instructing nursing students. The theory was applicable in research and practice due to its holistic approach that conceptualized how a client system responded to external stressors and how interventions helped achieve optimal wellness while preserving energy. Neuman's Systems theory provided a conceptual model for defining the phenomenon of inquiry, specifications of how to investigate it, and collecting and analyzing the resultant data (Neuman, 1996).

In the nursing domain, including anesthesia nursing, the focus lies in administering pharmacotherapeutics to render a patient unconscious to tolerate surgery and treat pain from surgical procedures using efficacious agents like opioids. These interventions are meant to meet the human needs of promoting health and wellness without any untoward sequelae (Ume-Nwagbo et al., 2006).

According to Neuman and Fawcett (2002), a client – may be an individual or a group of people – was viewed as an open system. A client system was comprised of five interactive variables: physiological (internal functions), psychological (mental processes and interactive environmental effects, both internally and externally), sociocultural, developmental (age-related), and spiritual (spiritual beliefs) (See Appendix D).

The Neuman systems model portrayed the client as an open circle surrounded by many concentric circles. The innermost circle constituted the *basic structure,* and it is made up of factors common to all living persons like pulse, blood pressure and genetic composition, and strengths and weaknesses of system organs. The surrounding concentric circles *represent lines of resistance* (LOR), whose function is to manage stressors and maintain homeostasis. Following the LOR are two circles; the outer accordion-like circle is termed the *flexible line of defense* (FLD), and its function is to provide a buffer that prevents stressors from invading the system. When the FLD expands and moves outwards, it provides more protection; when the FLD contracts inwards, less protection is provided. The second inner circle is called the *normal line of defense* (NLD) (Neuman & Fawcett, 2002).

Poor nutrition, fatigue, and daily stress can cause the FLD to contract due to a reduction in its buffering power. The NLD, which develops over time, represents a client system's usual wellness level, and it is affected by coping patterns, lifestyle factors, developmental, spiritual, and cultural influences. If environmental stressors pierce the NLD veil, the LOR is activated to protect the *basic structure* (Neuman & Fawcett, 2002).

The nurse enters the client's world to promote balance and stability, which are achieved by assessing internal and environmental stressors' ramifications. The client is then aided to readjust to achieve an optimal state of wellness despite the stressors. Following the drawing of a nursing diagnosis, nursing goals and outcomes are then formulated. The patient is then acted upon using three *preventions* as *interventions*, namely: primary, secondary, and tertiary. Primary interventions maintain the state of wellness through reinforcement of the FLD. Secondary interventions are utilized after illness ensues following the penetration of the NLD to regain stability. Lastly, tertiary strategies are comprised of education and support to assist the client/client system in readapting and restoring wellness (Neuman & Fawcett, 2002).

For this project's purposes, pain was viewed as an external stressor, multimodal therapies were analogized to primary interventions, and opioids were viewed as secondary interventions. The patient was viewed as an open system upon which surgery (a stressful event) was done, bringing to bear the five variables. A nurse anesthetist addresses these variables in an attempt to restore balance. Internal functions like temperature and heart rate are maintained within normal ranges or homeostasis in the physiological realm.

In the psychological realm, the CRNA attempted to meet the patient's needs through calm and reassuring interactions to decrease anxiety, keeping in mind that the patient's perceptions are shaped by sociocultural, developmental, and spiritual beliefs. This knowledge informs the anesthetist that a patient's perception of pain is a complex stressor influenced by many factors and requires individualized attention (Neuman & Fawcett, 2002) (see Appendix D). Neuman's Systems model speaks to the patient's needs, interaction with the CRNA, and the various possible interventions in meeting the patient's needs and alleviating stressors. With those individual needs in mind, the Iowa Model-Revised then provides the conceptual framework upon which a systemic process can be built upon, moving from an individual to a system.

According to Melynk and Fineout-Overholt (2019), the Iowa Model-Revised was easy to use and well suited for interprofessional collaboration because it provided a conceptual framework for clinicians for making decisions about practices that affect clinical and administrative outcomes. At the onset, clinicians were encouraged to be inquisitive of current practices to identify *triggering issues* and *opportunities* to improve care. Triggers and opportunities arose from clinical or patient-identified issues, organizational or external initiatives, new evidence, regulations or accrediting agency requirements, and care philosophy (see Appendix E). This QI project was an opportunity for improving care triggered by the ongoing opioid crisis in our nation and the lack of an opioid-sparing protocol at the implementation site.

Aligning a topic to organizational goals is important in securing stakeholder support. The key elements include the clinical ***P**roblem*, the patient ***P**opulation*, ***I**ntervention*, ***C**omparison* group, and desired ***O**utcome*. The acronym PICO is a derivative of these elements (Melynk & Fineout-Overholt, 2019). The PICO question for this QI project was outlined in chapter 1.

The next crucial step in the Iowa Model-Revised is to assemble, appraise, and synthesize the available body of evidence through a systemic literature search. Upon completing a critical evaluation of the literature, an affirmation of finding sufficient evidence leads to designing and piloting the desired change. In designing and piloting the change, the Iowa Model Collaborative (2017) calls for engaging patients, verifying their preferences, considering resource availability, developing a local protocol, creating an evaluation plan, and collecting baseline data.

Other pertinent steps include preparing relevant clinicians, promoting the desired change, and collecting and reporting post-pilot data. Piloting enables one to assess readiness and offers improvement opportunities (Melynk & Fineout-Overholt, 2019). This conceptual framework's final stages involve sustaining the change through constant engagement of key personnel, monitoring key indicators, hardwiring change into the system, reinforcing as the need arises, and disseminating findings.

The Iowa Model was ideal for implementing an opioid-sparing multimodal protocol because it allowed several feedback loops where decisions were made before proceeding to the next step. It further promoted the inclusion of multidisciplinary team members, fostered stakeholders' engagement, and promoted disseminating knowledge, which is at the heart of promoting an EBP culture within and outside an organization (Melynk & Fineout-Overholt, 2019). An opportunity for implementing a multimodal opioid-sparing anesthetic for women aged 18 to 65 was identified as a practice change project. The change would improve patient care by alleviating pain treatment with agents other than opioids in light of the opioid epidemic. Current evidence supported the implementation of ERAS pathways, especially opioid-sparing modalities, in this population.

This chapter discussed the methodology utilized to yield the pertinent literature regarding MOSA, specifically persistent opioid use, acute opioid tolerance, and opioid-induced hyperalgesia and ERAS pathways. After that, a discussion ensued to amalgamate this quality improvement project based on Neuman's Systems model and the Iowa Model as the conceptual framework and research paradigm alignment. Chapter III will include a detailed methodology on how this QI project was operationalized and what data was collected to evaluate effectiveness.

Chapter III: Methodology

The methodology for this Quality Improvement change project is a product of a gap analysis that identified a lack of a standardized anesthesia protocol (a trigger) in a northeast Pennsylvania hospital that performs hysterectomies. Triggers, which may be realized through clinical experiences, current literature, or practice guidelines, are reformulated as questions or problems that require further investigation (Brosnan, 2017). It was proposed that implementing a MOSA protocol for women aged 18-65 undergoing robotic hysterectomy would result in decreased use of opioids perioperatively and lower pain scores compared to patients who did not receive the protocol - opioid monotherapy. Other anticipated benefits beyond this project's scope included the early resumption of ADLs, decreased persistent opioid use, and decreased opioid misuse and diversion.

Project Plan

According to Brosnan (2017), identifying the importance of the organization's leaders was essential in gaining their commitment and support for a successful project. Once support was obtained, a multidisciplinary team approach was utilized to ensure adequate representation of experts and diverse ideas. Research literature was obtained using relevant keywords. A predetermined methodology, including exclusion and inclusion criteria, results, and conclusions, was used to review the literature. The evidence obtained supported and validated the need for change. Other forms of validation that were used included clinical experts, theoretical principles, and case reports. If the evidence obtained did not support the planned change, an additional inquiry on the subject matter was conducted (Melnyk &Finehout-Overholt, 2019).

The Iowa Model-Revised (2017) is an approach to change using available evidence to promote quality patient care. The new treatment's benefits and risks would be examined to guide future changes or evaluations of the project (Brosnan, 2017).

Brosnan (2017) recommended that if the desired outcome were supported by the pilot project, invigorating the staff by highlighting successes would ensure a smooth transition, essential for sustained change. Once the project was underway, the project was continually evaluated based on structures, processes, and outcomes for impact on care quality through casual conversations with staff. The results will be disseminated to expand the body of knowledge.

The lack of a standardized perioperative protocol for multimodal preventative analgesia for women undergoing robotic hysterectomy formed this project's foundation. An opportunity for anesthesia delivery improvement was recognized. Clinical observations, experience, formal education, and evidence-based research support and justified implementing MOSA to promote safe and effective perioperative analgesia while minimizing opioid use.

Patient EMRs were retrospectively reviewed for demographics, type of surgery, opioid usage and characteristics, pain scores, and complications. Opioids administered were converted to MMEs for ease of comparison. Overreliance on opioid monotherapy, lack of knowledge between visceral and somatic pain, and lack of education on optimal analgesia for staff and patients were identified using a fishbone diagram as root causes contributing to the practice concern (Moran et al., 2017).

An already established protocol was adopted to reduce the amount of opioids administered perioperatively (Brown et al., 2018; Boysen et al., 2018). It was anticipated that this established protocol could be adapted for robotic hysterectomy cases to decrease by half the amount of opioids administered. The protocol was based on the concept of multimodal preventative analgesia supported in the literature (see Appendix B).

The protocol was presented to the anesthesia department leaders for review and approval, leading to creating a MOSA order set. All the drugs utilized in the protocol were readily available. The project subjects were a convenient sample of all the women undergoing robotic-assisted laparoscopic hysterectomy and meeting the inclusion criteria of 18-65 years, BMI ≤ 40, no cardiac or respiratory pathology, and had signed informed consent for anesthesia. A patient education pamphlet on the numeric pain scale and the differentiation of somatic pain (which may respond to opioids for relief) from visceral pain (which may respond to other interventions like repositioning) was utilized.

Patients were educated on the day of surgery by the admitting RN in the preoperative area. The pamphlet served as an educational reinforcement of the protocol for the nursing staff. (see Appendices C and H). Laminated copies of the pain scale and the differentiation between somatic and visceral pain were presented to the nurse educator and approved for use. The copies were then disseminated to the PACU as a tool to aid in pain assessment.

Data was collected regarding pain level before surgery, pain level expectation after surgery, current use of pain medication, total opioids administered perioperatively, pain score upon arrival in PACU, and the total amount of opioids given in PACU before discharge (see Appendix F). The MOSA protocol was implemented over several weeks, and the results were evaluated for effectiveness based on the MMEs documented and self-reported pain scores.

Organizational Setting

This project took place in the surgical area at a community hospital in the Northeast of the United States. The surgical area is comprised of three distinct areas: the preoperative surgical holding area (holding), the operating room (OR), and the Post Anesthesia Care Unit (PACU). Registered Nurses (RNs) work in all the perioperative areas with Certified Registered Nurse Anesthetists (CRNAs), providing the anesthetic under a physician anesthesiologist's supervision in the OR. The hospital performs over 400 robotic surgeries, 300 of which are robotic hysterectomies. The organizational structure supports employee-led quality improvement initiatives that rely on current evidence.

Patient Participation/Selection

The project participants were a convenience sample of all patients ages 18-65 undergoing robotic hysterectomy irrespective of underlying preoperative diagnosis. For this project's purposes, no consideration was given to marital status, socioeconomic status, racial or ethnic group, or education level. The exclusion criteria included intraoperative complications such as conversion to open hysterectomy, blood loss of over 2000 milliliters, blood transfusion, failure to extubate, and intraoperative death. No stipend was offered for participation, and a separate consent for utilizing MOSA was not necessary since the consent for anesthesia covered the protocol. An Institutional Review Board (IRB) authorization was obtained from Bloomsburg University and hospital where this project was conducted. Patients who were unable to express their pain level using the numeric pain scale were excluded.

Project Implementation

The project was implemented after receiving the authorization of the IRBs of Bloomsburg University and the selected site of implementation. According to Melynk and Fineout-Overholt (2019), changing an organization's process is a highly emotional experience requiring individual change and strong leadership support. A majority of healthcare providers and clinical administrators in the anesthesia department supported this quality improvement project. Patient education included the pain scale, optimal analgesia, and the differences between somatic pain and visceral pain. This brief encounter was conducted by the admitting RN and took less than 5 minutes. The anesthesiologist conducted the preoperative assessment, ordered preventative analgesia medications and anxiolytic as indicated, and obtained anesthesia consent. All questions regarding the anesthetic plan were addressed.

The preoperative nurse administered the medications ordered (Appendix B), and the CRNA took the patient to the OR for surgery, where induction of anesthesia was performed. The appropriate MOSA agents were administered (Appendix B). Following endotracheal intubation and insertion of an orogastric tube (connected to low intermittent suction to avoid aspirating oral medications), the patient was monitored and managed according to the American Association of Nurse Anesthetists Standards of Practice. Standard 7, which outlines the planning, implementation, and management of anesthesia care, requires the CRNA to implement and, if needed, modify the anesthesia plan of care by continuously assessing the patient's response to the anesthetic and surgical or procedural intervention until the responsibility has been accepted by another anesthesia professional.

This care plan did not include opioids as the first line of agents to mitigate tachycardia, hypertension, or increasing intra-abdominal pressure. The anesthetic plan included beta-receptor blockade, alpha-2-agonists, and neuromuscular blocking agents as first-line agents (Koepke et al., 2018). After an uneventful case, muscle paralysis was reversed, the inhalational anesthetic agents discontinued, and the patient was extubated upon meeting the extubation criteria. After that, the patient was transported to PACU following emergence from anesthesia.

Upon arrival in PACU, the patient's self-reported pain level was recorded. If it exceeded the desired level of ≤ 4/10, ketorolac 15-30 mg IV was administered. Narcotics were administered as a rescue if the desired pain level of ≤ 4/10 was not achieved within ten minutes of intravenous ketorolac administration. After meeting all the discharge criteria, the patient was discharged from PACU.

Ethical Considerations

Collaborative Institutional Training Initiative (CITI) training was completed, and certificates were obtained in June 2020. An IRB authorization was sought before commencing any work on implementing the MOSA protocol. Confidentiality was ensured following the Health Insurance Portability and Accountability Act (HIPAA) of 1996 guidelines and the use of de-identified patient codes to ensure privacy and prevent inappropriate disclosure. All forms and data collected were stored in digital files in password-protected files in password-protected network computers. The ethical principles of justice – the fair distribution of resources; nonmaleficence – do not harm; beneficence - maximization of benefits and minimization of risks; and respect for autonomy – respecting self-determination, were strictly adhered to throughout this project. Patients provided written consent for participation in this project and were monitored and treated to minimize pain.

Timeline of Activities

According to Moran et al. (2017), a timeline helps with the organization of tasks, narrowing the focus to meet a reasonable timeframe and maintaining a level of scholarly rigor (see Appendix G). This project was discussed on multiple occasions with the clinical advisor, the initial discussion being on 12/10/2019. The availability and dispensing of drugs were informally discussed with the pharmacy staff on 4/6/2020. Support for the concept of a practice change project was obtained from the clinical director of anesthesia. CITI training was completed on 6/20/ 2020, and an IRB worksheet for Bloomsburg University was completed in July 2020.

Another IRB was submitted to the clinical site shortly after receiving authorization from the academic institution, which was also subsequently granted. Staff and patient education pamphlets with the numeric pain scale were submitted to the education director of perioperative services and approved for use in August 2020. A copy of the MOSA regimen was circulated to the anesthesiologists and CRNAs in August 2020. A spreadsheet template for data collection was developed in July 2020.

Stakeholders Involved

Adequate planning, enough time allocation for EBP consideration, and supportive interdisciplinary colleagues were important to consider when implementing this QI project (Melynk &Fineout-Overholt, 2019). The clinical director of anesthesia was identified as a supporter and was updated on the project progress periodically.

The pharmacy director provided input on drug availability and cost implications. Intravenous acetaminophen was cost-prohibitive when an oral formulation was acceptable. The gynecological surgeons were contacted, and the established protocol was presented. Protocol support was received with a focus on minimizing room turnover time.

The education department provided input on patient and staff educational materials. Education helped decrease anxiety and promote compliance. Pamphlets were prepared and presented to staff to reinforce key points.

Measurement Instruments

The Numeric Pain Scale (Appendix C) was used to measure the patient's self-reported pain level before and after surgery. This 11 point verbally administered instrument required minimal training, as it was already widely used throughout the hospital for assessing pain and is easy for patients to understand. It has been validated (Convergent validity compared to Verbal

Rating Scale *r* = 0.90 to 0.92) and deemed reliant (Cronbach's alpha = 0.888; test-retest reliability r= 0.72–0.78) by various studies (Good et al., 2001; Gordon et al., 2016). Some patients required opioids to relieve pain. All the opioids administered were converted to Morphine Milligram Equivalents (Appendix A) for ease of comparison between the two groups, namely: the traditional group compared versus the MOSA group (US Department of Health and Human Services/Centers for Disease Control and Prevention (CDC), 2016). The commonly administered opioids included morphine, fentanyl, and hydromorphone.

Data Collection Procedures

The EMRs were retroactively reviewed, and the following data were extracted (Appendix F): Patient's age, estimated blood loss, intraoperative complications, MMEs administered, pain scores before surgery and after surgery, as well as total dosages of all the MOSA drugs administered.

Data Analysis

Descriptive data analysis, including mean, mode, median, and regression analysis, was performed using the Statistical Package for Social Sciences (SPSS). Regression analysis is used to determine whether a relationship exists between an independent variable (amount of opioids used, age, race, etc.) and dependent variable (pain level). ANOVA is an acronym for Analysis of Variance, which is sometimes referred to as the Fisher Analysis of Variance. ANOVA helps a researcher determine if a relationship exists between dependent and independent variables.

Resources Used for Project Completion

This QI project involved time to educate direct care staff, engage stakeholders and collect and analyze data. The numeric pain scale and other educational materials were printed and laminated at the researcher's expense of $65. The researcher ensured that the site of project implementation incurred no stationary costs. Because this QI build on an established process, there was no need to reassign staff or create new roles. The multimodal therapy process and education were incorporated easily into one of the scheduled monthly educational meetings.

This chapter discussed the proposed methodology for implementing this QI project, including ethical considerations, a timeline of activities, and the statistical analysis. The next chapter, Chapter IV, will discuss the results obtained.

Chapter IV: Results

This QI project was a result of a practice gap identified at a local community hospital. Opioids were the mainstay treatment for perioperative pain, but an alternative for surgical pain relief was sought given the ongoing opioid epidemic (CDC, 2019). Studies suggested that multimodal therapies' inclusion decreased or eliminated opioid utilization in minimally invasive procedures without adversely affecting the patient experience (White et al., 2019; Koepke et al., 2018). This project's overarching purpose was to implement a multimodal opioid-sparing anesthesia protocol for female patients undergoing robotic-assisted laparoscopic hysterectomy to demonstrate that they received optimal analgesia by evaluating their pain before surgery and upon arrival in PACU. The following are the results of this project.

Sampling Procedure

A total of 33 participants underwent the MOSA protocol. The participants were a convenience sample of all female patients scheduled for robotic hysterectomy, who met the inclusion criteria between September and November 2020. The exclusion criteria included intraoperative complications such as conversion to open hysterectomy, blood loss of over 2000 milliliters, blood transfusion, failure to extubate, and intraoperative death. In the studied population, two participants were excluded because of conversion to open. One was excluded due to a blood loss of over 2 liters and administration of packed red blood cells. Five patients were excluded for not meeting the inclusion criteria of 18-65 years of age.

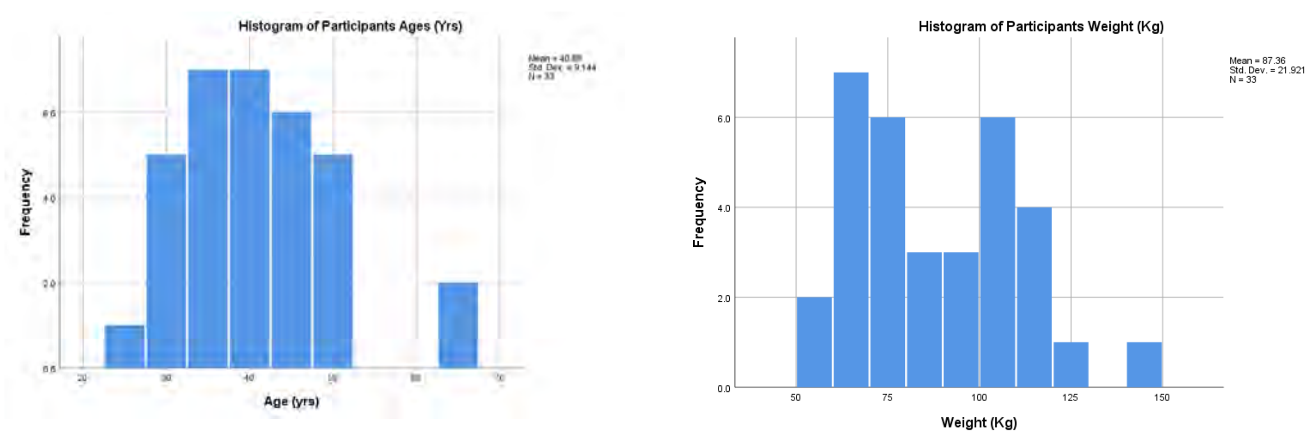
All participants were educated preoperatively regarding the pain scale, optimum analgesia, differentiation between somatic and visceral pain, and the MOSA protocol. SPSS was utilized to perform descriptive analytics, central tendency measures, and variance analysis, including t-test, to test the null hypothesis that there is no difference in the amount of opioids administered using the MOSA protocol versus the traditional opioid monotherapy technique.

Study Sample

The project participants (n=33) ranged between 25 and 64 years (mean 40.88 years; SD 9.14), and the participants' weight ranged from 50 to 143 kg (mean 87.36; SD 21.92), as shown in figure 1, which demonstrates a near-normal distribution.

Figure 1

Demographics Data of Participants



The participants' median height was 165 cm, and the average blood loss was 38.6 ml for all the cases, with one outlier noted to have a blood loss of 250 ml.

Self-reported pain scores were obtained in the preoperative holding area and then immediately upon arrival in PACU. Two patients reported a pain score of 1/10; three reported 3/10, and one reported 4/10; the remaining participants reported 0/10 (n=27; median=0; SD=1.09). Fifty-five percent of the participants received opioids intraoperatively (n=18), while thirty-three percent (n=11) received opioids in PACU. Twenty-one percent of the patients received a TAP block (n=7). In the cohort that received opioids intraoperatively, only one participant received a TAP block and reported a pain score of 0/10, thus receiving no opioids in PACU. The remaining participants required opioids (n=18 out of 33), reaffirming the reported observation of opioid-induced hyperalgesia in the literature – opioid use begets more opioids to relieve pain (Bekhit, 2010).

Although two of the nine patients (22%) that received a TAP block required opioids in PACU, one reported a pain score of only 3/10, and the other reported a 4/10, which meets the PACU discharge criteria for surgical patients. According to Tsui and Rosenquist (2017), TAP blocks offer an opioid-sparing effect due to their effectiveness in relieving pain, but unfortunately it was the least offered intervention (n=9).

Table 1 shows the morphine milligram equivalents of patients who underwent the MOSA protocol and those that did not (from a matched cohort). In the MOSA protocol, the average MMEs were 1.54 mg, while the non-MOSA cohort averaged 6.89 mg. T-test analysis showed that the 33 participants who received the MOSA protocol (M = 1.53, SD = 2.53) compared to the 33 participants in the non-MOSA cohort (M = 6.88, SD = 4.41) demonstrated statistically significant lower opioid requirements $t(32) = 8.97$, p=.05

Table 1

Comparing MOSA and non-MOSA Mean MMEs Administered

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Total MMEs	33	1.5376	2.53392	.44110
Non MOSA MMEs	33	6.8836	4.40779	.76730

Figures 2 and 3 show the MMEs for the MOSA and non-MOSA cohorts. Both figures show a unimodal distribution with decreasing frequencies as the number of opioids administered increased. The MOSA protocol shows the highest frequency of MMEs = 0 milligrams, while the highest non-MOSA frequency was MMEs = 5.

Figure 2

Non-MOSA MMEs of a Matched Cohort Undergoing Robotic Hysterectomy

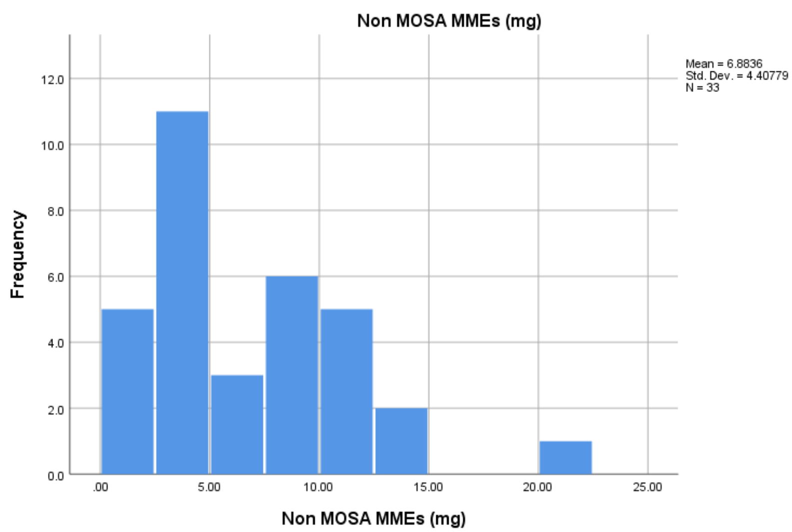
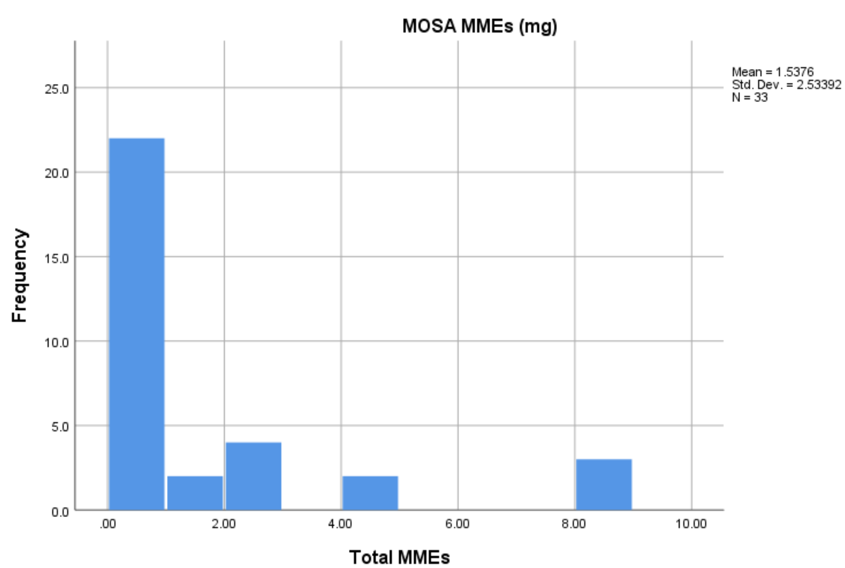


Figure 3

MOSA MMEs of Participants



SPSS analysis shows that in the MOSA protocol group, the median of total MMEs administered was 0.48 with a range of 0 to 8.84 ($M = 1.54$, $SD = 2.53$). A matched cohort for age from the previous year of patients who underwent a robotic hysterectomy using opioid-only monotherapy yielded median MMEs administered of 5.02 with a range of 1.2 to 20.6 ($M = 6.88$, $SD = 4.41$).

Chapter IV summarized the findings of the study question, "Will multimodal opioid-sparing anesthesia (MOSA) for women aged 18-65 undergoing robotic-assisted laparoscopic hysterectomy provide optimal analgesia?" The findings support utilizing MOSA protocol led to a lower requirement of opioids in the study participants. Chapter V will discuss and conclude the findings of this project. Implications and the significance for nursing practice will also be discussed, along with recommendations and suggestions for future research in the realm of opioid-sparing or opioid-free anesthesia.

Chapter V: Conclusion

Implications

The thematic underpinnings for all DNP projects should focus on applying scientific evidence to improve patient outcomes (AACN, 2006). This quality improvement project relied on evidenced-based practices that mitigate the utilization of opioids as the sole pain therapy for patients undergoing surgery. Through a stepwise process that relied on the Iowa model and the principles of Neuman's model, the MOSA protocol was successfully implemented in a medium-size hospital in northeast Pennsylvania.

Chapter five contains a summary of the findings with recommendations for future research and a conclusion of the findings. The utilization of multimodal therapies in anesthesia can decrease the amount of opioids used in surgery without compromising optimal analgesia. The decreased reliance on opioids benefits society by decreasing incidents of opioid misuse, diversion, and abuse.

Discussion

The concept of multimodal analgesia is not new in anesthesia; however, the concept was not widely known or discussed at the project site. The research, preparation, and implementation of the MOSA protocol was the first project ever undertaken by a nurse anesthetist in a doctoral program at this clinical site, highlighting the importance of nursing doctoral education in improving patient outcomes by translating evidence into practice.

This project identified important stakeholders in the anesthesia department. Stakeholders are vital in providing a supportive environment for other anesthetists to pursue similar projects in the future independently or as part of the pursuit of doctoral education. Unlike many disciplines, the intimate nature of providing anesthesia care requires a provider to be keenly aware of minute changes in a patient's vital signs while under anesthesia to meet the patient's needs, including comfort or pain relief, therefore expanding an anesthesia provider's armamentarium in non-opioid pharmacotherapy benefits patients.

Utilizing many modalities to deter pain transmission through known pathways and receptors effectively decreases opioid administration during anesthesia and the ensuing recovery periods (Koepke et al., 2018). On average, participants of the MOSA protocol required 1.54 mg of morphine equivalents compared to the 6.88 mg (4.5 times more) in the non-MOSA cohort to attain optimal pain relief. Although opioids are less expensive than multimodal agents due to their generic nature, White et al. (2019) found that patients who were part of a multimodal cohort required 41percent less opioid usage perioperatively without a significant increase in their pain. This resulted in fewer incidences of PONV, early resumption of ADLs, and early discharge. All these measures led to cost savings due to avoidance of using other drugs to treat opioid untoward effects or savings attained from short hospitalizations because reimbursements are not commensurate with prolonged hospital stays.

Although Swenson et al. (2018) determined that factors associated with persistent opioid use following surgery included age ≥ 50 and being African-America, no such association was established in the cohort studied. Additionally, no pattern was discernible between the participants' educational level or geographical location of residence.

This study reaffirmed similar observations made by Tabler (2016) that reliance on opioids led to more opioids administered perioperatively and by Colvin et al. (2013), who identified opioid tolerance and hyperalgesia as contributors to dose escalation and poor pain management. Colvin et al. (2013) identified the importance of peripheral nerve blockade and multimodal agents such as ketamine and TAP blockade, which target alternative pain transmission pathways.

Dissemination/Sustainability

Dissemination is not only a requirement for sharing one's findings to stakeholders; it is also essential to informing other professionals of results that promote patient outcomes and contribute to scientific knowledge (Melnyk & Fineout-Overholt, 2019).

Knowledge gained from this QI project, including methodology and results, will be shared through a poster presentation at an upcoming College of Science and Technology (COST) research day at Bloomsburg University. Additionally, a presentation to peers at the project implementation site is planned for the spring of 2021, where other CRNAs will be welcome to share their own experiences with the MOSA protocol to promote sustainability. An annotated manuscript will be prepared for submission to various platforms, including the nurse anesthesia journal and other pertinent websites.

Conclusion

This QI project showed the importance of multimodal agents in sparing opioid usage in anesthesia without compromising patient comfort. In the future, with more anesthesia providers being exposed to the practice of opioid-sparing and opioid-free techniques, the reliance on opioids as the primary agents for pain management will decrease. Future researchers should examine the minimum number of agents required to constitute a multimodal therapy and the role of preoperative diagnosis such as malignancy in influencing the use of opioids as rescue agents to treat pain in an opioid-sparing protocol. Lastly, as Moore (2018) cautions, pain should never be under-treated as a result of using an opioid-sparing protocol.

References

Alzahrani, S., & Hasan, A. A. (2019). Transformational leadership style on nursing job satisfaction amongst nurses in hospital settings: Findings from systematic review. *Global Journal of Health Science*, *11*(6), 25. https://doi.org/10.5539/gjhs.v11n6p25

American Association of Colleges of Nursing. (2006). *The essentials of doctoral education for advanced nursing practice*. https://www.aacnnursing.org/Portals/42/Publications/DNPEssentials.pdf

American College of Obstetricians and Gynecologists. (2015, March). *Robotic surgery in gynecology*. https://www.acog.org/clinical/clinical-guidance/committee-opinion/articles/2015/03/robotic-surgery-in-gynecology

Beauchamp, G. A., Winstanley, E. L., Ryan, S. A., & Lyons, M. S. (2014). Moving beyond misuse and diversion: The urgent need to consider the role of iatrogenic addiction in the current opioid epidemic. *American Journal of Public Health*, *104*(11), 2023–2029. https://doi.org/10.2105/ajph.2014.302147

Bekhit, M. H. (2010). Opioid-induced hyperalgesia and tolerance. *American Journal of Therapeutics*, *17*(5), 498–510. https://doi.org/10.1097/mjt.0b013e3181ed83a0

Beloeil, H., Laviolle, B., Menard, C., Paugam-Burtz, C., Garot, M., Asehnoune, K., Minville, V., Cuvillon, P., Oger, S., Nadaud, J., Lecoeur, S., Chanques, G., & Futier, E. (2018). POFA trial study protocol: A multicentre, double-blind, randomised, controlled clinical trial comparing opioid-free versus opioid anaesthesia on postoperative opioid-related adverse events after major or intermediate non-cardiac surgery. *BMJ Open*, *8*(6). https://doi.org/10.1136/bmjopen-2017-020873

Bicket, M. C., Long, J. J., Pronovost, P. J., Alexander, G. C., & Wu, C. L. (2017). Prescription opioids commonly unused after surgery: a systematic review. *JAMA Surgery*, *152*(11), 1066–1071. https://doi.org/10.1001/jamasurg.2017.0831

Bonnie, R. J., Kesselheim, A. S., & Clark, D. J. (2017). Both urgency and balance needed in addressing opioid epidemic. *Jama*, *318*(5), 423. https://doi.org/10.1001/jama.2017.10046

Boysen, P. G., Pappas, M. M., & Evans, B. (2018). An evidence-based opioid-free anesthetic technique to manage perioperative and periprocedural pain. *Ochsner Journal*, *18*(2), 121–125. https://doi.org/10.31486/toj.17.0072

Brummett, C. M., Waljee, J. F., Goesling, J., Moser, S., Lin, P., Englesbe, M. J., Bohnert, A. S. B., Kheterpal, S., & Nallamothu, B. K. (2017). New persistent opioid use after minor and major surgical procedures in US adults. *JAMA Surgery*, *152*(6), e170504. https://doi.org/10.1001/jamasurg.2017.0504

Brosnan, C. A. (2017). Conceptual models for evaluation in advanced nursing practice. In J. V. Hickey & C. A. Brosnan. (Eds.). (2017). *Evaluation of health care quality for DNPs* (2nd ed., pp. 189-206). Springer Publishing Company.

Brown, E. N., Pavone, K. J., & Naranjo, M. (2018, November). Multimodal general anesthesia: Theory and practice. *Anesthesia & Analgesia, 127*(5), 1246-1258. https://doi.org/10.1213/ane.0000000000003668

Buchman, D. Z., Leece, P., & Orkin, A. (2017). The epidemic as stigma: The bioethics of opioids. *Journal of Law, Medicine & Ethics*, *45*(4), 607–620. https://doi.org/10.1177/1073110517750600

Centers for Disease Control and Prevention. (2019, November 01). *CDC in action: 2018 response to the opioid crisis*. https://www.cdc.gov/opioids/framework/accomplishments.html

Chen, E. Y., Marcantonio, A., & Tornetta, P. (2018). Correlation between 24-hour predischarge opioid use and amount of opioids prescribed at hospital discharge. *JAMA Surgery*, *153*(2), e174859. https://doi.org/10.1001/jamasurg.2017.4859

Crowder, C. M., Palanca B. J., & Evers, A. S. (2017). Mechanisms of anesthesia and consciousness. In P. G. Barash, B. F. Cullen, R. K. Stoelting, M. K.Cahalan, M. C. Stock, R. A. Ortega, S. R. Sharar, & N. F. Holt (Eds.), *Clinical anesthesia* (8th ed. pp 219-240). Wolters Kluwer.

Cicero, T. J., & Ellis, M. S. (2017). The prescription opioid epidemic: A review of qualitative studies on the progression from initial use to abuse. *Dialogues in clinical neuroscience*, *19*(3), 259–269.

Colvin, L. A., Bull, F., & Hales, T. G. (2019). Perioperative opioid analgesia—when is enough too much? A review of opioid-induced tolerance and hyperalgesia. *The Lancet*, *393*(10180), 1558–1568. https://doi.org/10.1016/s0140-6736(19)30430-1

Dahan, A., Niesters, M., Smith, T., & Overdyk, F. (2017). Opioids. In P. G. Barash, B. F. Cullen, R. K. Stoelting, M. K.Cahalan, M. C. Stock, R. A. Ortega, S. R. Sharar, & N. F. Holt (Eds.), *Clinical anesthesia* (8th ed. pp 505-526). Wolters Kluwer.

Florence, C. S., Zhou, C., Luo, F., & Xu, L. (2016). The economic burden of prescription opioid overdose, abuse, and dependence in the United States, 2013. *Medical Care*, *54*(10), 901–906. https://doi.org/10.1097/mlr.0000000000000625

Gaunt, M., Alghamdi, D., & Grissinger, M. (2014). *Results of the 2013-2014 opioid knowledge assessment: progress seen, but room for improvement - Digital Collections - National Library of Medicine*. Collections.Nlm.Nih.Gov. http://resource.nlm.nih.gov/101641576

Good, M., Stiller, C., Zauszniewski, J. A., Anderson, G. C., Stanton-Hicks, M., & Grass, J. A. (2001). Sensation and distress of pain scales: Reliability, validity, and sensitivity. *Journal of Nursing Measurement*, *9*(3), 219–238. https://doi.org/10.1891/1061-3749.9.3.219

Gordon, D. B., de Leon-Casasola, O. A., Wu, C. L., Sluka, K. A., Brennan, T. J., & Chou, R. (2016). Research gaps in practice guidelines for acute postoperative pain management in adults: Findings from a review of the evidence for an american pain society clinical practice guideline. *The Journal of Pain*, *17*(2), 158–166. https://doi.org/10.1016/j.jpain.2015.10.023

Gupta, A. (2009). Patient perception of pain care in hospitals in the United States. *Journal of Pain Research*, *2009*(2), 157–164. https://doi.org/10.2147/jpr.s7903

Hah, J., Bateman, B., Ratliff, J., Curtin, C., & Sun, E. (2017). Chronic opioid use after surgery: Implications for perioperative management in the face of the opioid Epidemic. *Anesthesia & Analgesia*, *125*(5), 1733–1740. https://doi.org/10.1213/ANE.0000000000002458

Hedegaard, H., Miniño, A., & Warner, M. (2020). *Drug overdose deaths in the United States, 1999-2018*. https://www.cdc.gov/nchs/data/databriefs/db356-h.pdf

Herzig, S. J., Rothberg, M. B., Cheung, M., Ngo, L. H., & Marcantonio, E. R. (2013). Opioid utilization and opioid-related adverse events in nonsurgical patients in US hospitals. *Journal of Hospital Medicine*, *9*(2), 73–81. https://doi.org/10.1002/jhm.2102

Iowa Model Collaborative. (2017). Iowa model of evidence-based practice: Revisions and validation. Worldviews on Evidence-Based Nursing, 14(3), 175-182. https://doi.org/10.1111/wvn.12223

Joly, V., Richebe, P., Guignard, B., Fletcher, D., Maurette, P., Sessler, D. I., & Chauvin, M. (2005). Remifentanil-induced postoperative hyperalgesia and its prevention with small-dose ketamine. *Anesthesiology*, *103*(1), 147–155. https://doi.org/10.1097/00000542-200507000-00022

Kehlet, H., & Dahl, J. B. (2003). Anaesthesia, surgery, and challenges in postoperative recovery. *The Lancet*, *362*(9399), 1921–1928. https://doi.org/10.1016/S0140-6736(03)14966-5

Kivunja, C. (2018). Distinguishing between theory, theoretical framework, and conceptual framework: A systematic review of lessons from the field. *International Journal of Higher Education*, *7*(6), 44. https://doi.org/10.5430/ijhe.v7n6p44

Koepke, E. J., Manning, E. L., Miller, T. E., Ganesh, A., Williams, D. G. A., & Manning, M. W. (2018). The rising tide of opioid use and abuse: The role of the anesthesiologist. *Perioperative Medicine*, *7*(1). https://doi.org/10.1186/s13741-018-0097-4

Lal, M. M. (2019). Leading effectively through change. *JONA: The Journal of Nursing Administration*, *49*(12), 575–576. https://doi.org/10.1097/nna.0000000000000816

Leissner, K. B., Shanahan, J. L., Bekker, P. L., & Amirfarzan, H. (2017). Enhanced recovery after surgery in laparoscopic surgery. *Journal of Laparoendoscopic & Advanced Surgical Techniques, 27*(9), 883-891. https://doi.org/10.1089/lap.2017.0239

Luch, A. (2009). Molecular, clinical, and environmental toxicology. asel: irkh user.

Macres, S. M., Moore, P. G., & Fishman, S. M. (2017). Acute pain management. In P. G. Barash, B. F. Cullen, R. K. Stoelting, M. K. Cahalan, M. C. Stock, R. A. Ortega, S. R. Sharar, & N. F. Holt (Eds.), *Clinical anesthesia* (8th ed. pp 1562-1606). Wolters Kluwer

McEvoy, M. D., Scott, M. J., Gordon, D. B., Grant, S. A., Thacker, J. K., Wu, C. L., Gan, T. J., Mythen, M. G., Shaw, A. D., & Miller, T. E. (2017). American Society for Enhanced Recovery (ASER) and Perioperative Quality Initiative (POQI) joint consensus statement on optimal analgesia within an enhanced recovery pathway for colorectal surgery: Part 1—from the preoperative period to PACU. *Perioperative Medicine, 6*(1). https://doi.org/10.1186/s13741-017-0064-5

Melnyk, B. M., & Fineout-Overholt, E. (2019). *Evidence-based practice in nursing and healthcare : a guide to best practice* (4th ed.). Wolters Kluwer.

Milstead, J. A. (2016). *Health policy and politics : a nurse's guide* (5th ed.). Jones & Bartlett Learning.

Montgomery, R., & McNamara, S. A. (2016). Multimodal pain management for enhanced recovery: reinforcing the shift from traditional pathways through nurse-led interventions. *AORN Journal*, *104*(6), S9–S16. https://doi.org/10.1016/j.aorn.2016.10.012

Moran, K. J., Burson, R., & Conrad, D. (2017). *The doctor of nursing practice scholarly project: a framework for success* (2nd ed.). Jones & Bartlett Learning.

Moore, D. L. (2018). Opioid Omission Is Not Opioid Sparing. Response to "Surgery-Induced Opioid Dependence [Letter to the editor]. *Anesthesia & Analgesia*, *126*(5), 1789–1790. https://doi.org/10.1213/ane.0000000000002861

National Institute on Drug Abuse. (2020, May 27). *Opioid overdose crisis*. https://www.drugabuse.gov/drug-topics/opioids/opioid-overdose-crisis

Neuman, B. (1996). The Neuman systems model in research and practice. *Nursing Science Quarterly*, *9*(2), 67–70. https://doi.org/10.1177/089431849600900207

Neuman, M. D., Bateman, B. T., & Wunsch, H. (2019). Inappropriate opioid prescription after surgery. *The Lancet*, *393*(10180), 1547–1557. https://doi.org/10.1016/S0140-6736(19)30428-3

Neuman, B., & Fawcett, J. (2002). *The Neuman systems model* (4th ed.). Prentice-Hall.

Porter-O'Grady, T., & Malloch, K. (2018). *Quantum leadership: creating sustainable value in health care* (5th ed.). Jones & Bartlett Learning.

Pyati, S., Wahal, C., & Kumar, A. (2018). Advances in regional anaesthesia: A review of current practice, newer techniques and outcomes. *Indian Journal of Anaesthesia*, *62*(2), 94. https://doi.org/10.4103/ija.ija_433_17

Rudd, R. A., Aleshire, N., Zibbell, J. E., & Gladden, R. M. (2016). Increases in drug and opioid overdose deaths — United States, 2000–2014. *MMWR. Morbidity and Mortality Weekly Report*, *64*(50-51), 1378–1382. https://doi.org/10.15585/mmwr.mm6450a3

Schuchat, A., Houry, D., & Guy, G. P. (2017). New data on opioid use and prescribing in the United States. *Jama, 318*(5), 425. https://doi.org/10.1001/jama.2017.8913

Sinha, R., Bana, R., & Sanjay, M. (2019). Comparison of robotic and laparoscopic hysterectomy for the large uterus. *JSLS: Journal of the Society of Laparoendoscopic Surgeons*, *23*(1), e2018.00068. https://doi.org/10.4293/JSLS.2018.00068

Swenson, C. W., Kamdar, N. S., Seiler, K., Morgan, D. M., Lin, P., & As-Sanie, S. (2018). Definition development and prevalence of new persistent opioid use following hysterectomy. *American Journal of Obstetrics and Gynecology*, *219*(5), 486.e1-486.e7. https://doi.org/10.1016/j.ajog.2018.06.010

Tabler, N. G. (2016). Over-reliance on opioids poses quality and cost concerns. *Healthcare Financial Management: Journal of the Healthcare Financial Management Association*, *70*(12), 40–45. https://pubmed.ncbi.nlm.nih.gov/29901345/

Tsui, B. C. & Rosenquist, R. W. (2017). Peripheral nerve blockade. In P. G. Barash, B. F. Cullen, R. K. Stoelting, M. K. Cahalan, M. C. Stock, R. A. Ortega, S. R. Sharar, & N. F. Holt (Eds.), *Clinical anesthesia* (8th ed. pp 945-1002). Wolters Kluwer.

Ume-Nwagbo, P. N., DeWan, S. A., & Lowry, L. W. (2006). Using the Neuman systems model for best practices. *Nursing Science Quarterly*, *19*(1), 31–35. https://doi.org/10.1177/0894318405284125

US Department of Health and Human Services/Centers for Disease Control and Prevention (CDC). (2016). *Calculating total daily dose of opioids for safer dosage.* https://www.cdc.gov/drugoverdose/pdf/calculating_total_daily_dose-a.pdf

Wijk, L., Udumyan, R., Pache, B., Altman, A. D., Williams, L. L., Elias, K. M., McGee, J., Wells, T., Gramlich, L., Holcomb, K., Achtari, C., Ljungqvist, O., Dowdy, S. C., & Nelson, G. (2019). International validation of enhanced recovery after surgery society guidelines on enhanced recovery for gynecologic surgery. *American Journal of Obstetrics and Gynecology*, *221*(3), 237.e1-237.e11. https://doi.org/10.1016/j.ajog.2019.04.028

White, K. D., Azadi, S., Pauley, A., Mitchell, D. B., & Zgheib, N. B. (2019). Reducing postoperative opioids after minimally invasive hysterectomy with enhanced recovery. *Marshall Journal of Medicine, 5*(1), 50-69. https://doi.org/10.33470/2379-9536.1209

Yin, H.-H., Tse, M. M. Y., & Wong, F. K. Y. (2015). Systematic review of the predisposing, enabling, and reinforcing factors which influence nursing administration of opioids in the postoperative period. *Japan Journal of Nursing Science*, *12*(4), 259–275. https://doi.org/10.1111/jjns.12075

Zhao, S., Chen, F., Feng, A., Han, W., & Zhang, Y. (2019). Risk factors and prevention strategies for postoperative opioid abuse. *Pain Research and Management*. https://doi.org/10.1155/2019/7490801

Zuo, Z. (2005). The role of opioid receptor internalization and beta-arrestins in the development of opioid tolerance. *Anesthesia & Analgesia*, *101*(3), 728–734. https://doi.org/10.1213/01.ane.0000160588.32007.ad

Appendix A

Morphine Milligram Equivalents

Opioid	Conversion Factor
Codeine	0.15
Fentanyl	2.4
Hydrocodone	1
Hydromorphone	4
Morphine	1
Oxycodone	1.5
Oxymorphone	3

(US Department of Health and Human Services/Centers for Disease Control and Prevention (CDC), 2016)

Appendix B

Proposed Non-Opioid Multimodal Agents

Preoperative	Intraoperative	Postoperative
Acetaminophen 975 mg PO Pregabalin 150 mg PO COX-II inhibitor Celecoxib 200 mg PO Ondansetron 4 mg IV	Ketamine 0.25-0.5 mg/kg bolus or infusion Magnesium 2-4 mg IV slow push/infusion Lidocaine 1mg/kg/hr (hold for TAP block) Dexamethasone 10 mg IV bolus Dexmedetomidine 0.5 mcg/kg loading dose slow IV push, then 0.3-0.5mcg/kg/hr or Clonidine 100mcg IV bolus Liposomal bupivacaine for TAP block	Ketorolac 15mg IV PRN

(Boysen et al., 2018; Brown et al., 2018)

Appendix C

Numeric Pain Scale

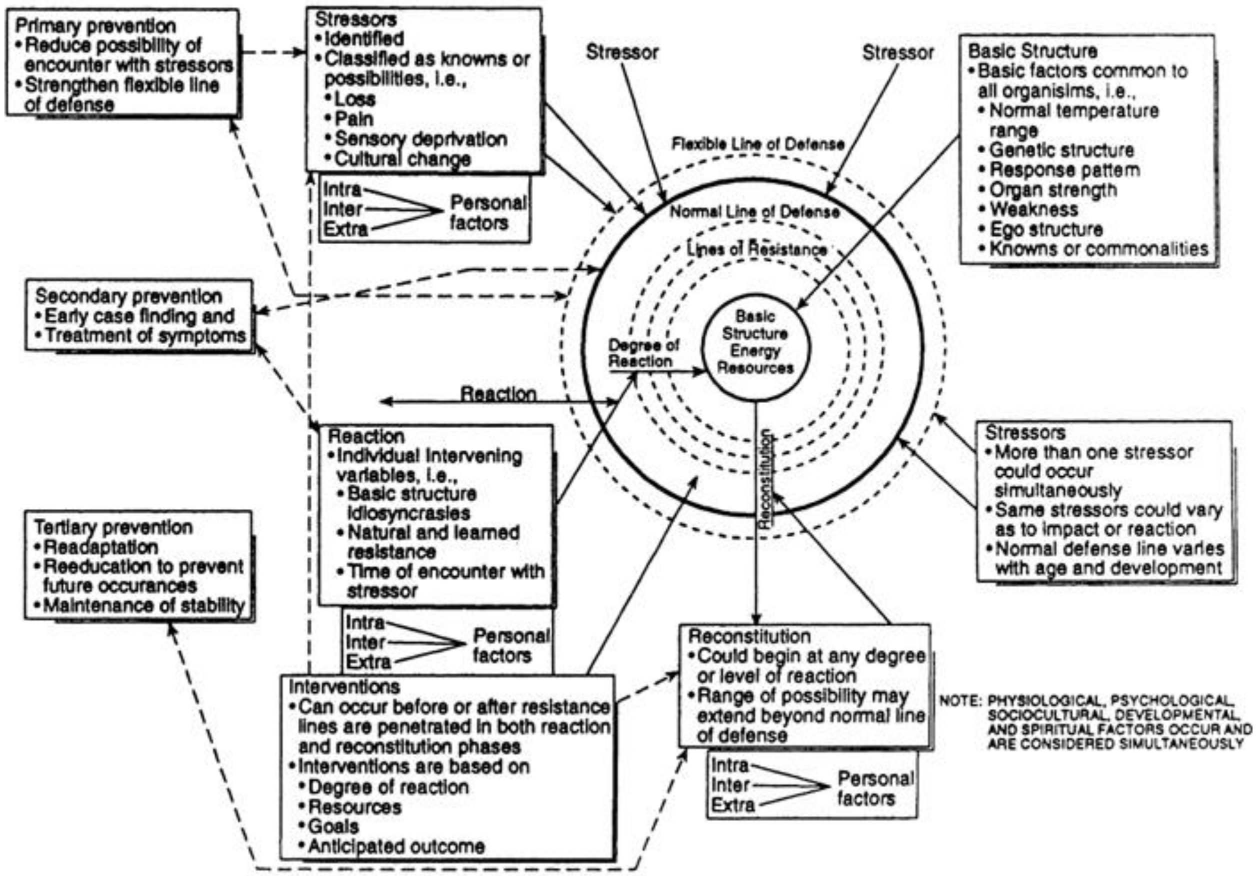
0-10 SCALE OF PAIN SEVERITY

Severity		Description of Experience
10	Unable to Move	I am in bed and can't move due to my pain. I need someone to take me to the emergency room to get help for my pain.
9	Severe	My pain is all that I can think about. I can barely talk or move because of the pain.
8	Intense	My pain is so severe that it is hard to think of anything else. Talking and listening are difficult.
7	Unmanageable	I am in pain all the time. It keeps me from doing most activities.
6	Distressing	I think about my pain all of the time. I give up many activities because of my pain.
5	Distracting	I think about my pain most of the time. I cannot do some of the activities I need to do each day because of the pain.
4	Moderate	I am constantly aware of my pain but I can continue most activities.
3	Uncomfortable	My pain bothers me but I can ignore it most of the time.
2	Mild	I have a low level of pain. I am aware of my pain only when I pay attention to it.
1	Minimal	My pain is hardly noticeable.
0	No Pain	I have no pain.

https://paindoctor.com/pain-scales/

Appendix D

Betty Neuman's Systems Model

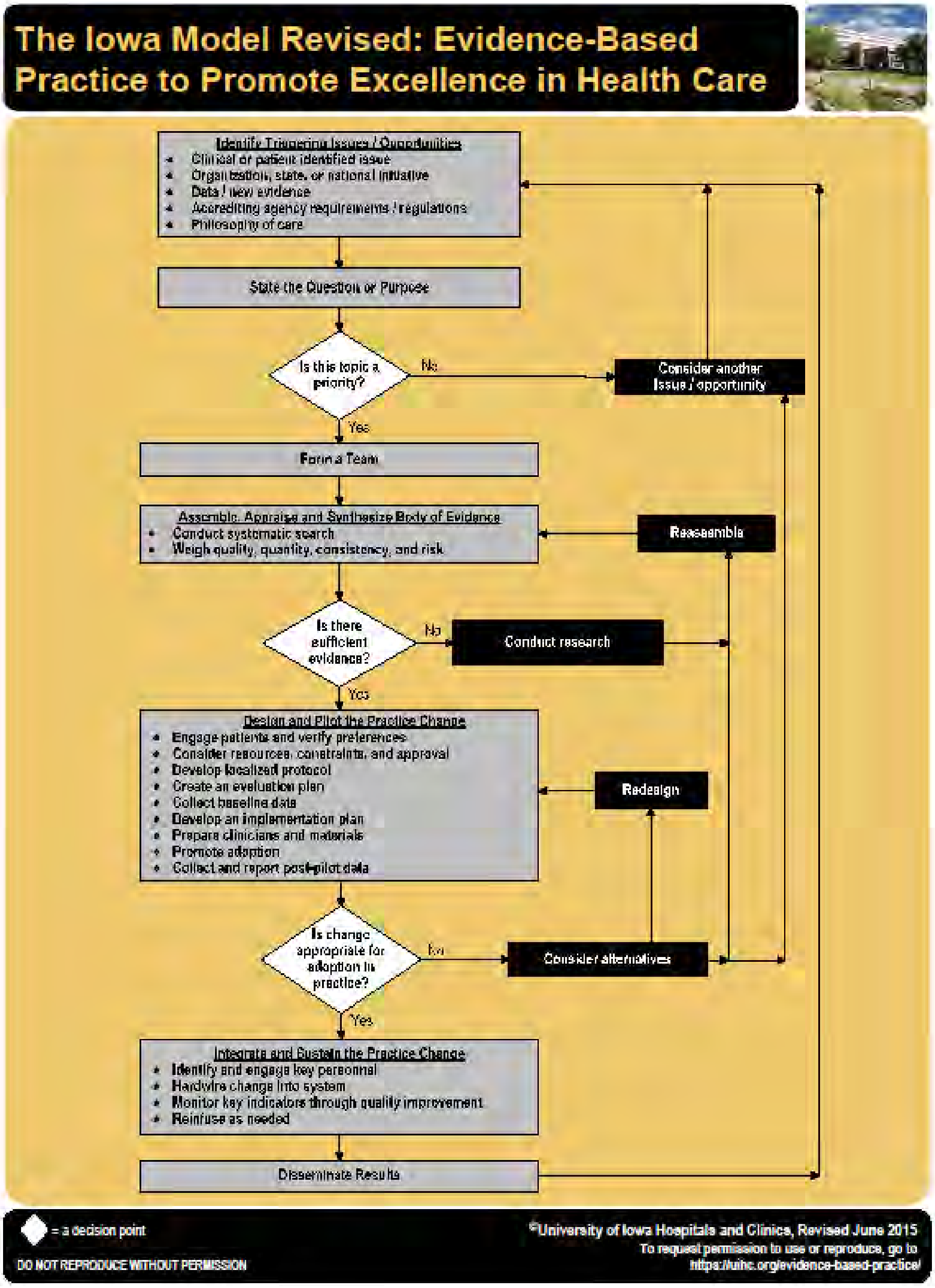


NOTE: Spiritual variable added.
SOURCE: Reprinted by permission of Betty Neuman.

https://pltfrmrsrcs.sagepub.com/images/betty-neuman/9780803948624-p17-1.jpg

Appendix E

The Iowa Model



Used/reprinted with permission from the University of Iowa Hospitals and Clinics, copyright 2015. For permission to use or reproduce, please contact the University of Iowa Hospitals and Clinics at 319-384-9098. Permission granted July 2020.

Appendix F

Sample Spread Sheet for Data Collection

Unique I/D & Age	Current Pain (0-10)	Expected Pain (0-10)_	Pain Meds (Y/N)	MMEs in OR	PACU Arrival Pain	MMEs in PACU	Total MMEs	Discharge Pain (0-10)	Notes

Appendix G

Timeline (Major Landmarks)

Date	Activity
12/10/2019	Initial discussion with the clinical advisor at the project site
6/5/2020	CITI training completed
08/05/2020	Educational institution IRB submission completed
8/13/2020	Project site (Healthcare Institution) IRB submission completed. Met with Institution's Research Liaison, J. Gombosi.
09/02/2020	Educational material submitted for approval
07/15/2020	Data spreadsheet template created
09/02/2020	Healthcare Institution IRB approval received
09/03/2020	Resubmission of academic institution's IR
09/10/2020	Academic institution's IR approval received
09/15/2020	Commencement of 1st case under MOSA protocol; success
11/23/2020	Retrospective chart review for comprehensive data collection started
3/15/2020	Completion of data analysis and writeup of final results, including poster board

Appendix H

Somatic Pain vs. Visceral Pain

Somatic Pain	Visceral Pain
Localized, aching, stabbing	Dull, colicky, or squeezing; referred