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A Multimodal Analgesic Virtual Reality Program to Reduce Opioid Exposure

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Abstract

The opioid crisis continues to be a public health concern. Traditionally, an opioid-centric approach treats postoperative pain. The following PICOT question guided this project: Will initiating a multimodal analgesic virtual reality quality improvement program (I) compared to current practice (C) decrease opioid requirements (O) in robotic hysterectomy patients (P) during the postoperative period (T)? Several articles promote non-opioid analgesia and non-pharmacological interventions, such as multimodal analgesia and virtual reality (VR) for pain management. This project reviewed pre- and post-implementation data after implementing new evidence-based multimodal analgesia and VR protocols. The project captured a total of 64 patients in the pre-implementation group. A total of 22 patients received both multimodal analgesia and VR in the post-implementation group. There was no statistically significant difference in total opioid consumption converted as morphine milligram equivalents (MME) between the pre-implementation and post-implementation groups. However, there was a statistically significant difference in multimodal analgesia administered in Pre-op between the pre-implementation and post-implementation groups. In conclusion, the execution of the multimodal analgesic VR program allowed for nursing adoption of novel evidence-based practices (EBP) and promoted the use of non-opioid and non-pharmacological interventions. Although the combination of multimodal analgesia and VR did not reduce opioid consumption, the practice of incorporating multimodal analgesia as a standard workflow improved.

A Multimodal Analgesic and Virtual Reality Program to Reduce Opioid Exposure

Federal involvement in combatting the national opioid crisis began in the 1970s when Title II of the Comprehensive Drug Abuse Prevention and Control Act was passed (Gross & Gordon, 2019). This act, also known as the Controlled Substances Act (CSA), required federal regulation of controlled substances and included formal recommendations for scheduling substances related to their potential for abuse (United States Drug Enforcement Act, n.d.). Both cultural changes and prescribing patterns detrimentally evolved during the 1990s (Baker, 2017) as healthcare accreditors began tethering patient satisfaction to the frequency of clinician pain management interventions (Ashburn & Fleisher, 2016). Between 1991 to 2013, the number of prescribed medications increased from 76 million to 97 million, an upward spiraling trend that may have been caused by the Food and Drug Administration's (FDA) release of OxyContin (Baker, 2017). OxyContin's manufacturers aggressively marketed towards high-prescribing physicians and released information that the medication was best suited for the treatment for non-cancer-related pain due to its low-risk for iatrogenic addiction (Zee, 2009). It was not until 2010 that the Affordable Care Act (ACA) required the Department of Health and Human Services (HHS) to declare pain as a public health concern ("Relieving Pain in America," 2016).

In December 2015, clinical practice guidelines emerged on the management of postoperative pain from the American Pain Society, the American Society of Regional Anesthesia, the American Society of Regional Anesthesia and Pain Medicine, and the American Society of Anesthesiologists' Committee on Regional Anesthesia, Executive Committee, and Administrative Council (Chou et al., 2015). Among some of the strong recommendations included providing patient and family-centered preoperative education and planning, administering multimodal therapies (including non-pharmacological techniques), and utilizing

oral opioids versus intravenous (IV) opioids because of their superior effects on postoperative pain.

With the call to change health care culture from opioid-centric to opioid-sparing, a concerted effort from perioperative clinicians is required to manage postoperative pain optimally. In one study, 10% of opioid naïve patients undergoing short-stay or same-day surgery and given low-dose opioid prescription for pain became long-term opioid users after one year (Alam, Gomes, Zheng, Mamdani, Juurlink, & Bell, 2012). Therefore, limiting the exposure during the immediate postoperative period may impact patient opioid usage in the long-run.

Making a difference globally, nationally, and at the state level to formally fight against the opioid epidemic requires strategic planning and ongoing commitment. One hospital in Southern California equipped its perioperative staff with virtual reality (VR), an innovative, disruptive technology. According to one meta-analysis, the authors concluded that VR is a useful pain management tool that reduces acute pain during medical procedures (Mallari, Spaeth, Goh, & Boyd, 2019). The purpose of this Doctor of Nursing Practice (DNP) project is to evaluate the implementation of a structured multimodal analgesic and virtual reality program to decrease opioid exposure and usage while effectively managing postoperative pain.

Significance of the Practice Problem

Millions of surgeries occur every year to heal or save lives (Meara et al., 2016). Unfortunately, the prevalence of poorly controlled postoperative pain due to adverse events continues to be the unresolved reality for many patients. The estimated cost to healthcare organizations is US $1,869±4,553 per patient (Gan, 2017). According to the Institute of Medicine (IOM), patients report pain after surgery 80% of the time, with varying levels ranging from moderate to severe and extreme (IOM, 2011). To address postoperative pain, surgeons

prescribe analgesic medications after surgery (Gan, Epstein, Leone-Perkins, Salimi, Iqbal, & Whang, 2018). Commonly, these medications include IV opioids such as morphine, hydromorphone, and fentanyl. One study by Gan et al. (2018) found that 45% of physicians surveyed were not concerned with the patient's risk of addiction in combination with acute usage of postoperative IV opioids. In another study, 6% of patients continued to take opioids after 90 days following both major and minor surgery (Brummet et al., 2017). This research suggested that more than 2 million patients transition from acute to chronic opioid consumption every year.

About 80% of heroin abuser's habits stem from opioids prescribed by doctors (Adams, Bledsoe, & Armstrong, 2016). Around 450,000 drug-related deaths were reported globally in 2015, with 160,000 related to drug use overdose and 118,000 pertaining to opioid use disorders (World Health Organization [WHO], 2018). In the United States, opioids caused more than half of the 70,200 drug overdose deaths reported in 2017, and about 130 Americans die from an opioid overdose daily (Centers for Disease Control [CDC], 2018). In the same year, over 11.4 million people abused their opioid prescriptions (U.S. Department of Health and Human Services [HHS], 2019). Interestingly in California, most opioid-related deaths are from prescription opioids, compared to synthetic opioids and heroin (National Institute on Drug Abuse [NIDA], 2019).

Postoperative pain can result from nociceptive pain, or a neuronal response to noxious stimuli (Czarnecki & Turner, 2018). Two types of nociceptive pain exist; somatic (localized, present in the skin, tissue, muscles, or bones) and visceral (diffuse, originating from deep inside the body). Both peripheral and central sensitizing factors are the consequence of postoperative pain, which requires adequate control through various opioid and non-opioid techniques (Luo & Min, 2017). Traditionally, an opioid-centric approach to postoperative pain management has

been used by clinicians (McEvoy et al., 2017). However, several articles promote a shift in tactics through minimizing opioid analgesia and incorporating non-opioid treatment modalities (Chou et al., 2015; Jones, Viswanath, Peck, Kaye, Gill, & Simopoulous, 2018; McEvoy et al., 2017).

Patients undergoing total laparoscopic hysterectomies typically experience the most intense incisional and visceral pain 30 minutes after surgery, and the pain gradually decreases over time (Choi, Kang, Song, Seok, Kim, & Kim, 2016). One study found that gynecologists prescribe two times the amount of opioids than the average consumption after a hysterectomy procedure and cite multifactorial reasons for this practice, such as patient satisfaction and reduced postoperative calls for refills (As-Sanie et al., 2017). Within the last three years, the robotic approach to gynecological surgery has become the surgical standard (Wright, et al., 2013), since the technology allows for easy adaptation from laparoscopic techniques (Lane, 2018). Surgeons appreciate the robotic approach for accuracy and precision because it allows for minimal invasiveness, an optimal field of view, and improved dexterity (Shah, Vyas, & Vyas, 2014). However, despite significant pain reduction with the robotic approach compared to the vaginal approach, morphine consumption remained the same in the recovery room in one study (Carbonnel et al., 2013). This suggests opioid-centric clinician culture persists despite improved outcomes.

PICOT Question

The following PICOT question guided this project: Will initiating a multimodal analgesic virtual reality quality improvement program (I) compared to current practice (C) decrease opioid requirements (O) in robotic hysterectomy patients (P) during the postoperative period (T)?

During a post anesthesia care unit (PACU) chart audit, robotic hysterectomy patients consumed the second-highest amounts of opioids in the recovery room. This population was chosen to best control the environment during the project pilot due to their high volumes of surgeries each week and outpatient status. Implementing a standardized multimodal postoperative analgesic protocol has been shown to improve pain management and reduce opioid consumption (Walker et al., 2019). Therefore, this project compared the new implementation of a multimodal analgesic virtual reality program against current unstandardized pain management practices and measured the total opioid administration converted as morphine milligram equivalents (MME). The definition of the postoperative period includes the time the patient is admitted to the PACU (including both Phase 1 and Phase 2) until the patient is discharged home.

Framework of the Problem

Framework

In the clinical setting, the PDSA cycle tests change and allows stakeholders to adopt new knowledge quickly (Picarillo, 2018). The Associates in Process Improvement cofounders further expanded the model to answer three questions and named it the Model for Improvement (Crowl, Sharma, Sorge, & Sorensen, 2015; Joshi, Ransom, Nash, & Ransom, 2014). The questions included: (1) What are we trying to accomplish?, (2) How will we know that a change is an improvement?, and (3) What change can we make that will result in improvement? The Model for Improvement was used as the framework to implement this DNP Project. It provided the structure for the project to positively impact clinical outcomes, organizational costs, and productivity (Crowl et al., 2015).

The Model for Improvement helped define this project's aims and outcomes (Crowl et al., 2015) and established a SMART (specific, measurable, attainable, realistic, and timely, [Dye,

2017]) goal. By providing virtual reality as a non-pharmacological intervention, can nurses decrease opioid exposure by 10% (a hospital executive goal) within the patient's recovery period? Multimodal analgesia, also known as providing the patient with two or more drugs or interventions that provide analgesic relief (American Society of Anesthesiologists Task Force, 2012), is today's standard (Mariano & Schatman, 2019). This concept is an integral component of enhanced recovery after surgery (ERAS) protocols (Montgomery & McNamara, 2016; Pogatzki-Zahn, Segelcke, & Schug, 2017; Tan, Law, & Gan, 2014), something already established at the hospital of study. Therefore, to answer the second question, this project would need to show decreased opioid administration and an increase in multimodal techniques to benefit the patient's surgical experience. The third question, "What change can we make that will result in improvement?" will be answered by focusing on a specific patient population (Crowl et al., 2015) that will benefit the most from this program.

Change Theory

Everett Roger's Diffusion of Change Theory is the foundation of this project as it describes the process of adopting innovations in healthcare (Dearing & Cox, 2018). Dearing & Cox (2018) defined diffusion as a social process among organizational stakeholders resulting from an evidence-based, innovative change. The process is dependent on when the change is adopted and accelerated by the perceived relative advantage (Lundblad, 2003). If the stakeholders' values align with the project's mission, there is greater compatibility and trialability. Every individual's needs vary and affect their appraisal of the innovation's advantages and disadvantages (Dearing & Cox, 2018).

Evidence Search Strategy

To most effectively explore multimodal pain management and virtual reality, an exhaustive systematic review of the literature occurred. The search included the following Medical Subject Headings (MESH) terms: "*pain management," "pain management/methods," "pain, postoperative," "analgesics, non-narcotic," and "virtual reality."* Databases used to conduct the search included CINAHL, EBSCO, ProQuest, and PubMed and included only primary sources. The following inclusion criteria were applied: (1) participants studied ≥ 18 years of age, (2) multimodal and/or non-pharmacologic approach to pain management, (3) articles written in English, (4) articles published within the last five years (2015-2020). Exclusion criteria included (1) participants studied < 18 years of age, (2) opioid approach to pain management, (3) non-English articles, (4) secondary sources, and (5) articles published more than five years ago.

The foundations of multimodal and non-pharmacologic approaches to pain management helped find superior methods compared to high-dose opioid administration. Articles were retained if they were relevant and less than five years old. Duplicated articles were eliminated. After applying the inclusion and exclusion criteria, 13 articles were chosen; 6 articles were based on multimodal analgesia, and 7 pertained to virtual reality as a non-pharmacological intervention.

Evidence Search Results and Evaluation

A review of the literature allowed for an extensive exploration of evidence-based practices (EBPs) to help create a multimodal analgesic VR program. An initial search using the Boolean operator "AND," as well as the MESH terms *"pain management," "pain management/methods," "pain postoperative,"* and *"analgesics, non-narcotic"* produced 57 articles. Searching the MESH terms "virtual reality" and "pain management" with the Boolean

operator “AND” resulted in 29 articles. The initial search resulted in a total of 86 articles. After completing a review of the abstracts and inclusion and exclusion criteria were applied, a thorough examination of 19 articles commenced. A total of 6 articles were removed due to secondary research and protocol-only designs, and a sum of 13 articles emerged for synthesis. See the PRISMA Flow Diagram in Figure 1.

One reviewer analyzed the articles in a standardized manner and utilized the Johns Hopkins Nursing Evidence-Based Practice Appraisal Tool to consider the literature's level of evidence and quality. Types of studies retained included retrospective cohort studies, quasi-experimental research, randomized control trials, randomized comparative effectiveness trials, non-experimental correlational research, and meta-analysis/systematic reviews. The level of evidence ranged from I-V (2 level I, 3 level II, 4 level III, and 3 level V). The majority of articles received a “Good” to “High” quality grade. Only one study was deemed “Low” quality due to insufficient data analysis information. One randomized controlled trial and three systematic reviews added strength to the evidence found.

Themes from the Evidence

The literature review identified the general characteristics of a successful pain management program. A synthesis matrix developed contrasting concepts and underlying ideas (see both Appendix and B). Similar themes included multimodal analgesia, clinician culture related to pain management, the benefits of reducing opioids in the perioperative period, and virtual reality as a non-pharmacological intervention.

Multimodal Analgesia

Several studies support the use of non-opioid analgesics (acetaminophen, NSAIDs, COX-2 inhibitors, and gabapentin/pregabalin) both preoperatively and postoperatively to improve pain

management (Cozowics et al., 2019, Smith, Young, Blosser, & Poole, 2019; Desai et al., 2018; Militsakh et al., 2018; Brandal et al., 2017; Brubaker, Kendall, & Reina, 2016). One high-quality retrospective cohort study saw a substantial reduction in opioids as COX-2 inhibitors and NSAIDs were administered (Cozowics et al., 2019). Contrastingly, another good quality retrospective cohort study found that as acetaminophen use per day increased in combination with NSAID administration, the primary outcome of median morphine milligram equivalents administered reduced (Smith et al., 2019).

Adverse effects were significantly reduced as a result of less opioid usage, which included a decrease in postoperative ventilation, critical care admission, obstructive sleep apnea (OSA), gastrointestinal complications (i.e., ileus; Cozowics, 2019), and decreased lengths of stay (Cozowics, 2019; Brandal et al., 2017). Adversely, Cozowics (2019) also pointed out that genitourinary complications did not increase as a result of the non-opioids used, suggesting that renal toxicity is not a risk factor associated with multimodal analgesia.

Clinician Culture

Healthcare providers can shift cultural perceptions to implement effective postoperative analgesia (Militsakh, 2018). There is an associated learning curve with the adoption of new methods of practice. Buy-in and adherence increase over time as clinicians denounce traditional perspectives of pain management. Although reticence may act as a barrier, witnessing the positive effects of alternative analgesia administration greatly impacts clinician behavior.

While most studies allude to clinician awareness, one study highlighted physician behavior as a barrier to proper opioid management (Brandal et al., 2017). Standard discharge order sets do not allow for customizable opioid prescribing; rather, they make it easier for physicians to order opioids on every patient. The study suggested educating physicians to

modify prescribing behaviors by evaluating objective data more thoroughly and following clinical practice guidelines to minimize opioid prescribing.

Reducing Opioids in the Perioperative Period

A similar theme throughout the literature revealed how the perioperative period creates an essential opportunity to stave chronic opioid usage since opioids are typically introduced to opioid-naïve patients postoperatively (Militsakh, 2018; Brandal et al., 2017). It is evident that reducing the availability of opioids can impact the opioid epidemic positively (Militsakh, 2018). Integrating non-opioid approaches in the hospital can reduce the administration of opioids (Smith et al., 2019), thereby reducing exposure and exploitation of high-risk drugs.

Virtual Reality

Similar to the non-opioid approaches, VR is a non-pharmacological intervention that can benefit patients' pain with minimal side effects (Spiegel et al., 2019; Chan, Foster, Sambell, & Leong, 2018; Vazquez, Lara, Miller, Wiederhold, & Wiederhold, 2019; Glennon et al., 2018; Mohammad & Ahmad, 2018, Scapin, Echevarria-Guanilo, Junior, Goncalves, Rocha, & Coimbra, 2018). The use of technology to distract the patient from their pain complements traditional pain management methods. VR is a superior tactic compared to other mediums, such as television (Speigel et al., 2019) or music (Glennon et al., 2018). The technology can treat acute pain intraoperatively or during medical procedures, but long-term carryover effects have not been proven (Mallari et al., 2019). However, one study proved VR's immediate pain reduction effects postoperatively (Glennon et al., 2018). Nurses commonly utilize the technology within the literature (Spiegel et al., 2019; Mohammad & Ahmad, 2018; Scapin et al., 2018), since it enhances their workflow, such as during painful dressing changes (Scapin et al.,

2018). While VR can be used to improve pain, it can also significantly reduce anxiety (Glennon et al., 2018; Mohammad & Ahmad, 2018).

Interestingly, one high-quality randomized comparative effectiveness trial found similar physician opioid prescribing practices in the study by Brandal et al. (2017), despite changes to pain management interventions (Spiegel et al., 2019). The study found that usual practice and equivalent MME administration had higher pain scores than the VR group, providing evidence that changes to prescribing practices are needed.

There was a high risk of bias in the systematic review by Chan et al. (2018). Many studies lacked prospective enrollment and rigorous adherence to CONSORT guidelines. It is also challenging to blind a participant to VR as an intervention. Therefore, future high-quality studies should be conducted to confirm the effects of VR.

The findings from this literature are multifaceted and recommend implementing multiple non-opioid medications or non-pharmacologic interventions, such as VR, to improve pain management from a nursing perspective. A primary limitation of this review included a lack of randomized control trials to recommend multimodal analgesia and virtual reality strongly. Most of the studies supported further research in various clinical settings.

Practice Recommendations

Based on a thorough review of the literature, the documentation supports a multifactorial approach to pain management in the form of both non-opioid and non-pharmacological interventions. It is strongly recommended with moderate-quality evidence to incorporate acetaminophen, NSAIDs, COX-2 inhibitors, and gabapentin/pregabalin throughout the entire perioperative period (Cozowics et al., 2019, Smith, Young, Blosser, & Poole, 2019; Desai et al., 2018; Militsakh et al., 2018; Brandal et al., 2017; Brubaker, Kendall, & Reina, 2016). The

addition of VR to an analgesic regimen was also strongly recommended with moderate quality evidence to decrease pain (Spiegel et al., 2019; Chan, Foster, Sambell, & Leong, 2018; Vazquez, Lara, Miller, Wiederhold, & Wiederhold, 2019; Glennon et al., 2018; Mohammad & Ahmad, 2018, Scapin, Echevarria-Guanilo, Junior, Goncalves, Rocha, & Coimbra, 2018). Both practices improve pain management and contribute to higher patient satisfaction while reducing the risk of opioid-related adverse effects. Therefore, these practice recommendations will be incorporated into this program.

Considering the Guidelines on the Management of Postoperative Pain, similar recommendations exist regarding multimodal therapies and cognitive-behavioral modalities. The panel recommended combining treatments, utilizing both analgesic medications and non-pharmacologic interventions as synergistic mechanisms of action to provide adequate pain relief (Chou et al., 2016). Although the recommendation in the guidelines for cognitive-behavioral modalities is weak with moderate-quality evidence, they are noninvasive, minimal risk interventions with positive effects on postoperative pain and anxiety.

There is strong evidence that supports patient and family-centered preoperative education and planning (Chou et al., 2016). Customized programs for a heterogeneous patient population can improve postoperative opioid consumption by managing patient expectations and allowing autonomy in the decision-making process. Also, the use of short-acting oral opioids versus IV opioids is strongly recommended with moderate-quality evidence. Nevertheless, nurses should include discharge education on tapering, discontinuation, and proper disposal of opioids. A visual Venn diagram highlights the structure of the Multimodal Analgesic Virtual Reality program (see Figure 2).

Project Setting

This DNP EBP change project took place in a large, nonprofit acute-care community hospital located in Southern California. As one of the largest hospitals in Orange County, its mission is to provide the highest quality care to its surrounding communities as a trusted and nationally recognized health care leader with 588 licensed beds. The population surrounding the hospital and its institutes includes close to 2 million residents, which comprises 21.9% children/youth, 63.9% adults, and 14.1% seniors. The population's ethnic backgrounds include White (46.4%), Hispanic or Latino (31.1%), Asian (18.1%), and other races (5.5%).

The perioperative environment consists of three nursing units: Preoperative/Same-Day-Services Unit (SDS), Operating Room (OR), and Post Anesthesia Care Unit (PACU). Implementation of the project occurred on the second-floor pavilion with six dedicated OR suites. Both the Pavilion SDS and PACU have twelve patient bays with up to six nurses staffing each unit, depending on the caseload, acuity levels, and census.

Needs Assessment

In January 2020, the hospital gained recognition as a Center of Excellence in Robotic Surgery. However, a needs assessment and practice gap analysis revealed that the robotic hysterectomy patients were the second-highest consumers of opioids in the PACU compared to other procedures. Based on the population's opioid consumption and outpatient status, the robotic hysterectomy patient population became the project's participant pool. Since most patients discharge on the same day of surgery, the program's effectiveness was closely measured within the PACU clinical setting. A chart audit included 64 patients, which calculated the total opioid consumption in both PACU Phase I and Phase II. This data and preoperative prescribing practices were taken to the hospital's Chief Executive Officer (CEO), Chief Nursing Officer (CNO), Chief of Strategy, and Perioperative Executive Leadership. Organizational support was

achieved based on opioid administration in the PACU and the strategic goal of implementing new technologies within the hospital. The DNP project was approved and allowed to move forward. A SWOT Analysis highlighted the internal and external forces that may impact implementation (see Figure 3). Plans for sustainability included testing the program in a microclimate to gain buy-in from stakeholders involved with the project. Executive leadership supported the idea of scaling virtual reality into all areas of patient care, as well as strategizing to accomplish a new hospital designation called "Opioid Safe Hospital Designation," if the program demonstrates emerging success.

Project Overview

The project's mission was to replace the opioid-centric nursing and physician culture with opioid-sparing techniques to improve pain management and reduce adverse side effects. The project's vision addressed the organization's intention to become a dominant competitor in the immersive extended realities (XR) market. A 10% reduction of total opioid consumption before patient discharge from PACU deemed the project's success. A full risk assessment (see Figure 4) and management plan addressed issues, such as nausea and vomiting during VR usage, fall risk, or disruption of clinician workflows. Labeled strategies guided the stakeholders to transfer, accept, mitigate, or eliminate the risks (Kogon, Blakemore, Wood, 2015). The impact and probability scores ranked the level of influence each risk may play. A subsequent written plan included communication with specific stakeholders who could support the process and manage solutions. This was communicated to all nurses during their training.

Objectives

The organization's Pavilion PACU was the primary setting for the project where the majority of patients recover in Phase I and transition to Phase II without leaving the department.

The nursing unit consisted of 12 patient bays and a nursing ratio of 1:2 patients, depending on the patient's acuity level and type of surgery. Up to 6 nurses employed the unit at one time, flexing with the census and level of care that patients required. On any given weekday, 1-6 robotic hysterectomy patients underwent surgery, which allowed for an adequate participant selection. The short-term objective was for clinicians to adhere to protocol guidelines during the project pilot. The long-term objective was for clinicians to adopt the practices into their everyday workflow to optimally care for every surgical procedure in a standardized manner.

Stakeholders' Roles

The DNP student played a vital role as the project lead. Clinical leadership was critical to facilitate interdisciplinary collaboration and drive change at the nursing bedside (Bender, Connelly, & Brown, 2012). The project lead facilitated perioperative nursing, anesthesiologist, and surgeon education. Each healthcare provider maintained a role that was imperative for project success. The surgeon oversaw all care provided from beginning to end. Their buy-in was crucial to help support the program and its mission. The anesthesiologists oversaw all medications given during the perioperative period. Their role was to write specific doctor's orders limiting IV opioids and promoting both non-opioid medications and non-pharmacological techniques. The preoperative nurses were in charge of recruiting participants and educating them about the new program. The intraoperative nurses drove communication about the project to the postoperative period, where the PACU nurse initiated the multimodal analgesic virtual reality program's pain management protocols. Interprofessional communication amongst all stakeholders was the foundation of the project's effectiveness (Busari, Moll, & Duits, 2017).

Project Plan (Method)

The Model for Improvement guided the DNP Project and allowed stakeholders to understand how the project measured success and identified opportunities for improvement. The model required a PDSA cycle, a tool to test rapid improvements for both small and large-scale projects (Picarillo, 2018). The team was engaged and learned from the project, which allowed for acceptance or rejection of refined workflows. The knowledge attained affected the system globally as adoption spread to other areas of the hospital. The project lead was the DNP student. The nursing preceptor, nursing researcher, and physician champions were the project mentors. The Planning Stage occurred from October-May 2020. The Do Stage took place during the first week of June 2020. The Study Stage commenced from the second week of June and ran until the end of July 2020. Lastly, the Act Stage, or project wrap-up, occurred during August-December 2020. The PDSA cycle and full details regarding the Multimodal Analgesic Virtual Reality program are outlined below. See Appendix C for the full project schedule.

Planning Stage

The Planning Stage took place from October 2019 to June 2020. This program's structure was developed based on the literature review and enhanced with both physician and nurse feedback. Interdisciplinary collaboration guided decision-making for specific practice changes. The latest evidence-based recommendations for perioperative pain management were embedded within the program. The DNP student partnered with an anesthesiologist, surgeon, and nursing Unit Practice Council to help form clinician education and medication administrative practices.

The Director of Extended Reality Therapeutics, the project’s sponsor, decided back in November 2019 to partner with AppliedVR. This company supports the delivery of safe and effective VR therapeutic technologies by treating health conditions with evidence-based, non-invasive, and opioid-sparing interventions (AppliedVR, 2019). Since the company was awarded

a grant by the National Institute on Drug Abuse (NIDA) for more than $2.9 million to study VR for both acute and chronic pain, it was an easy decision to utilize their technology for the organization's patient care needs. The equipment supplied by the company includes the PICO G2 4K HMD with SootheVR programming, as well as technical support available during regular business hours, Monday through Friday.

The business proposal for formal implementation and budgetary requirements was presented to the CEO, CNO, and Chief Strategy Officer back in February 2019. The budget is outlined in Figure 5. After attaining approval, a plan to reach the stakeholders involved with the project was created. The DNP nurse created a presentation curated for each healthcare provider group, including the nurses, anesthesiologists, and gynecology-oncology surgeons. Approval from each group was granted in May 2020.

Preoperative Setting

During the preoperative period, nurses were responsible for recruiting participants based on the inclusion and exclusion criteria (see Figure 6), and participants were chosen based on convenience and opportunity recruitment. Only Hospital Ambulatory Surgical (HAS) patients were included in the program due to their same-day discharge disposition. Surgical admit patients were excluded. The nurse introduced the VR head-mounted displays (HMDs) and instruction pamphlet (see Figure 7) to the patients if the criteria were met. Preoperative education was conducted on how to use the HMDs in the postoperative period after surgery. Pain management expectations were addressed by establishing goals for future pain medication administration. The patients trialed the HMD for about 5 minutes, allowing them to navigate the simulations and pick between guided-meditation, guided imagery, or interactive games. An

established time limit ensured operating room (OR) delays did not occur. If time allowed, patients were allowed to utilize the HMDs for more extended periods.

Anesthesiologists and surgeons were held accountable for ordering at least two preoperative multimodal analgesic medications, including the combination of acetaminophen, NSAIDs, COX-2 inhibitors, and gabapentin/pregabalin. The ordering practices depended on physician preference. Preoperative nurses were in charge of executing the orders and administering the medications to the patients prior to surgery.

Postoperative Setting

The World Health Organization's (WHO) Pain Relief Ladder served as the framework for pain medication administration in the PACU (see Figure 8). As an ethical consideration, opioids were not withheld from the patients—nurses administered medications based on the pain relief ladder. For patients who complained of pain on admission on a Numeric Rating Scale (NRS) 7-10/10, an opioid rescue plan was implemented, and IV opioids were administered to treat severe pain. For patients who complained of pain on a scale from 1-6/10, VR was utilized as a non-pharmacological intervention. Oral opioids (i.e., Norco, Percocet, or Roxicodone), in combination with tramadol and other non-opioid analgesics such as Toradol or Robaxin, were considered for patients who complained of pain on a scale from 5-6/10. Oral acetaminophen was administered for patients who complain of pain from 1-4/10.

Since the patients were not appropriate for oral medications immediately after surgery due to the risk of nausea and vomiting, they received both IV medications and VR as a non-pharmacological intervention until they were optimized for oral medications. Administration of IV opioids followed EPIC order set instructions to administer the lowest dose initially. The order also limited administration if the patient met opioid-naïve criteria. If the patient was

opioid-tolerant (used opioids for one week or longer or around-the-clock use is present of at least the following daily dose: 60 mg oral morphine, 60 mg oral hydrocodone, 30 mg oral oxycodone, 8 mg oral hydromorphone, fentanyl patch 25 mcg/hr, or the equivalent of another opioid), dosages increased to meet the needs of the patient following the initial lowest dose.

A VR utilization log sheet accompanied the patient's chart from the preoperative to postoperative setting (see Figure 9). The sheet was blue and visually alerted the nurses that the patient was a project participant. The preoperative nurse was responsible for writing in the patient's unique medical record number (MRN) and answering two questions: (1) Did the patient receive VR training?, and (2) Did the patient receive oral multimodal (≥2) medications in Pre-op? If the answer to both questions was yes, the preoperative nurse checked the box. Before the patient transferred to surgery, hand-off communication occurred between the preoperative and operating room nurses. After the procedure was complete, the operating room nurse communicated with the PACU nurse and indicated that the patient was a participant in the multimodal analgesic virtual reality program. PACU nurses admitted the patient to the nursing unit and ensured the patient was stable and cognitively appropriate for VR. They used the VR utilization log sheet to document the times the patient was wearing the HMD. A timer was set to ensure patients did not exceed 30 minutes. The patient could use the headset an unlimited amount of times, as long as the session did not exceed 30 minutes total. Nurses were allowed to make comments on the log. For example, if the intervention was discontinued due to nausea, the nurses wrote this information in the comment section. Once the patient was discharged or transferred, the log sheet was stored in a locked document box located on the nursing unit. The project lead was the only team member with access to the locked box. The information was transferred to a password-protected spreadsheet located on an encrypted, password-protected

USB flash drive. After moving the data, the sheet was dropped into the organization's document shred box.

Do Stage

The Do Stage took place during the first week of June 2020. All perioperative nurses received a nursing in-service provided in small groups. Attendance was required and supported by nursing executive leadership. During this time, nurses had the opportunity to test-run the HMDs on the unit. They had access to the equipment, and monitoring of proper cleaning and sanitizing procedures occurred. Nurses were required to clean the HMD before and after each patient's use with a PDI Sani-Cloth AF# Germicidal Disposable Wipe. A dry optical lens microfiber cloth or soft gauze was used to clean the headset lens after being wiped with the Sani-Cloth. If the participant complained of any discomfort (i.e., eye strain, nausea, dizziness, or headache) during the intervention, including pain caused by the HMD itself, nurses were advised to discontinue the HMD immediately. Appropriate care was provided based on the risk management plan presented during the nursing in-services.

Study Stage

The Study Stage commenced during the second week of June and ran until the end of July 2020. This stage marked the full project implementation phase. To ensure stakeholder bias was not a factor and workflows were not impacted after the project announcement, the cohort of 64 patients gathered during the needs assessment and practice gap analysis from January to March 2020 was utilized as the project's historical pre-intervention group. The program's structure was applied to clinician workflows, and data collection on the post-intervention group was conducted throughout the Study Stage. Data analysis variables were extracted from the EPIC electronic health record (EHR) and stored in a password-protected spreadsheet located

within an encrypted USB flash drive. A validated opioid calculator, known as the GlobalRxPh Opioid Conversions Calculator, was used to convert all IV and oral opioids to an equianalgesic form of oral morphine milligram equivalents (MME).

Act Stage

The Act Stage took place from August to December 2020. A comprehensive evaluation of the program and extensive data analysis comparing the pre-intervention group to the post-intervention was conducted. The synthesis of evidence was critically appraised, and written recommendations were presented to the organization's Executive Leadership team.

Project Evaluation

Evaluation Plan

The project evaluation plan included comparing pre- and post-implementation data and analyzing if there was a statistically significant clinical difference. An ad hoc selection method was used to recruit participants dependent on participant accessibility or proximity to the project (Jager, Putnick, Bornstein, 2017). The collection of pre-implementation data on 64 participants occurred during June 2020 on patient charts with a date of surgery between January and March 2020. Post-implementation data was collected from the second week of June to the end of July 2020. The reliability and validity of the data collection process remained consistent since there was only one data collector who ensured the steps were streamlined and uniform. Post-implementation recruitment strategies included selecting participants according to inclusion and exclusion criteria (see Figure 6). The nurses followed a process map algorithm to determine if the patient met the criteria. The map walked the nurse through the requirements in a step-wise fashion. Participants were selected if they were female, undergoing robotic hysterectomy outpatient surgery, English-speaking, and followed commands appropriately (no cognitive

deficits). The participants were excluded if they were in isolation precautions, cognitively impaired, non-English speaking, had open wounds to the head or neck, or had a history of seizures or claustrophobia.

Ethics, Human Subjects Protection, & Data Protection

Ethics and human subjects' protection were the project lead's priority during the project. Careful consideration of all human subjects' rights was completed during the proposal development. The DNP student sought approval from both the EBP Committee (EPRC) from the University of St. Augustine for Health Sciences and the Institutional Review Board (IRB) from St. Joseph Hospital as required by the hospital's policies and procedures. All protected health information (PHI) was stored on an encrypted flash drive and stored in a locked container when not in use. The project lead accessed the PHI via a password-protected hospital cloud. Another password was required to access the EPIC EHR. The anonymity of data was maintained by transferring the data to a password-protected Excel spreadsheet, only accessible by the project lead. This document was stored on the encrypted flash drive. Patient names were not transferred nor published in an identifiable manner. The hospital's Health Insurance Portability and Accountability Act (HIPAA) Compliance Officer reviewed all data collection tools before implementing and after implementing the project, which included the data collection sets. The project lead received approval at each stage.

Variables

The project lead collected data on multiple variables from both pre- and post-implementation participant groups. The primary variable warranting program success and feasibility included total opioid consumption converted to MME administered in the PACU during Phase I and II until patient discharge. The secondary variables included patient medical

record number (MRN), age, gender, race/ethnicity, body mass index (BMI), American Society of Anesthesiologists Classification (ASA), diagnosis, preoperative pain score, pain score at discharge, multimodal analgesia administered in Pre-op, length of stay (LOS) in PACU, and VR utilization time. The overall evaluation plan outlined variable names, descriptions, data sources, the possible range of values, levels of measurement (nominal, ordinal, interval, or continuous), categories of measures, and timeframe for collection (see Appendix D).

Power Analysis and Sample Size Determination

A priori power analysis was conducted to determine the minimum number of participants required for the project for an 0.80 power of finding a statistically significant difference in the total opioid administration converted as MME between the multimodal analgesic VR program and current practice, using the two-sample t-test. The 0.80 power for power analysis is the desired power of the test. The power analysis for the two-sample t-test was performed using Gpower 3.1.9.4 (Faul, Erdfelder, Buchner, & Lang, 2009) to determine the minimum sample size needed for this project. For a medium effect size of 0.5 (Cohen, 1988) and an alpha level = 0.05, the minimum sample size needed to achieve a .80 power was 128 participants (see Appendix E).

Data Analysis

Data were imported and analyzed using SPSS version 23 for Windows (IBM Corp., Armonk, NY). Data were examined using frequency tables and descriptive statistics for missingness and data entry errors. Participants with missing or erroneous data were excluded from data analysis, such as those who did not receive both multimodal analgesia in the preoperative area or those that refused VR in the PACU. Frequency tables (for categorical variables) and descriptive statistics (for continuous variables) were used to summarize (1) participants' demographics, including age, gender, race, BMI, ASA, and diagnosis warranting

procedure, (2) the event variables, included opioids prior to admission, preoperative pain score/level, multimodal analgesia administered in pre-op, pain at discharge, IV opioids administered in PACU, oral opioids administered in PACU, length of stay in PACU, and total VR utilization time (in minutes), and (3) the primary outcome variable, total opioid consumption converted as MME, for the two groups (pre-implementation (i.e., current practice) and the post-implementation group (multimodal analgesia + VR). Normality of the continuous study variables (total VR utilization time, length of stay in PACU, and total opioid consumption converted as MME) for the two groups (pre-implementation [i.e., current practice] and post-implementation group [multimodal analgesia + VR]) were examined using the Shapiro-Wilk normality tests (Field, 2013).

The project's primary purpose was to determine if the addition of two non-opioid interventions would impact the participant's postoperative opioid consumption. This was done by measuring if there was a statistically significantly difference in the event variables and the primary outcome variable between the pre-implementation (i.e., current practice) group and the post-implementation group that received both EBPs (multimodal analgesia + VR).

Results

The participant size for each of the study groups was: 64 (pre-implementation) and 22 (post-implementation; multimodal analgesia + VR). The categorical population variables of interest, including gender, race, ASA, and diagnosis for these two study groups are summarized in Table 1.

All participants were female who underwent the robotic hysterectomy procedure. The majority of the participants were White in the pre-implementation group (85.9%) and the multimodal analgesia + VR group (77.3; Table 1). The majority of the participants in the pre-

implementation group (73.4%) and the multimodal analgesia + VR group (68.2%) had an ASA classification equal to 2 (Table 2). For diagnosis, about one-third of the participants in the pre-implementation group (31.3%) and multimodal analgesia + VR group (31.8%) had a cancer-related diagnosis (Table 1).

Table 1

Summary (Frequency (%)) of Participants Variables (Gender, Race, ASA, and Diagnosis)

Variable	Pre (*N* = 64)	MA + VR (*N* = 22)
Gender		
Female	64 (100)	22 (100)
Male	0	0
Race		
White	55 (85.9)	17 (77.3)
Hispanic	1 (1.6)	0
Asian	5 (7.8)	2 (9.1)
Other	3 (4.7)	3 (13.6)
ASA		
0	2 (3.1)	0
1	2 (3.1)	2 (9.1)
2	47 (73.4)	15 (68.2)
3	13 (20.3)	5 (22.7)
Diagnosis		
Cancer	20 (31.3)	7 (31.8)
Other	44 (68.8)	15 (68.2)

The continuous participants' variables of interest, including age and BMI for these two study groups are summarized in Table 2. The average age for the pre-implementation group and the multimodal analgesia + VR group was 58.34 (*SD* = 12.90) and 57.32 (*SD* = 10.82), respectively (Table 2). The average BMI for the pre-implementation group and the multimodal analgesia + VR group was 27.33 (*SD* = 6.92), 28.86 (*SD* = 7.32), respectively (Table 2).

Table 2

Descriptive Statistics (Mean and standard deviation) for Participant Variables (Age and BMI)

Variable	Pre (*N* = 64)	MA + VR (*N* = 22)
Age	58.34 (12.90)	57.32 (10.82)
BMI	27.33 (6.52)	28.86 (7.32)

Table 3 shows the frequency tables for summarizing the categorical event variables, including opioids prior to admission, preoperative pain score/level, multimodal analgesia administered in pre-op, pain at discharge, IV opioids administered in PACU, and oral opioids administered in PACU, for these two study groups.

Almost all participants in the pre-implementation group (92.2%) and the multimodal analgesia + VR group (95.5%) had a low level (NRS of 5 or less) of preoperative pain prior to undergoing surgery (Table 3). Similarly, almost all participants in the pre-implementation group (98.4%) and all participants (100%) in the post-implementation group (multimodal analgesia + VR) had low level of pain at discharge (NRS of 5 or less; Table 3).

Table 3

Summary (Frequency (%)) of Categorical Event Variables

Variable	Pre (N = 64)	MA + VR (N = 22)
Preoperative pain		
Low pain (NRS 0-5)	59 (92.2)	21 (95.5)
High pain (NRS 6-10)	5 (7.8)	1 (4.5)
Multimodal analgesia administered in Pre-op		
No	43 (67.2)	0
Yes	21 (32.8)	22 (100)
Pain at discharge		
Low pain (NRS 0-5)	63 (98.4)	22 (100)

High pain (NRS 6-10)	1 (1.6)	0

Table 4 shows the results of the Fisher's exact tests for determining if there was a statistical significantly difference in each categorical event variable, including pre-operative pain score/level, multimodal analgesia administered in pre-op, pain at discharge, between the two groups of interest; between pre-implementation and multimodal analgesia + VR. According to Fisher's exact tests, there was no statistically significant difference in preoperative pain (p = 1.000) and pain at discharge (p = 1.000), between the pre-implementation group and the multimodal analgesia + VR group (Table 4). However, there was a statistically significant difference in multimodal analgesia administered in pre-op between the pre-implementation group and the multimodal analgesia + VR group ($p < 0.001$) (Table 4).

Table 4
Results of Fisher's Exact Tests

Variable	Pre vs. MA + VR
Pre-operative pain	1.000
Multimodal analgesia administered in pre-op	< 0.001
Pain at discharge	1.000

Table 5 presents the descriptive statistics of the two continuous event variables (length of stay and total VR utilization time). According to the results of Shapiro-Wilk normality tests, the data for length of stay for the pre-implementation group (p = 0.068) and the multimodal analgesia + VR group (p = 0.263) were normally distributed (Table 5). Thus, mean and standard deviations were used to summarize length of stay. The average time for length of stay (measured

in minutes) for the pre-implementation group and the multimodal analgesia + VR group was 156.33 (*SD* = 65.24) and 162.32 (*SD* = 44.74), respectively (Table 5).

Table 5
Descriptive Statistics of Continuous Event Variables

							Shapiro-Wilk		
Variable		*N*	*M*	*SD*	*Mdn*	*IQR*	*W*	*df*	*p*
Length of stay	Pre	64	156.33	65.24	143.0	86.8	0.965	64	0.068
	MA + VR	22	162.32	44.74	175.5	56.3	0.946	22	0.263
VR time	Pre	64	NA	NA	NA	NA	NA	NA	NA
	MA + VR	22	25.64	11.30	29.0	10.0	0.851	22	0.003

Primary Outcome Variable

Table 6 presents the descriptive statistics of the primary outcome variables (total opioid consumption converted as MME). According to the results of Shapiro-Wilk normality tests, the data for total opioid consumption converted as MME for the pre-implementation group ($p < 0.001$) and the multimodal analgesia + VR group ($p = 0.002$) were not all normally distributed (Table 6). Thus, median and IQR were used to summarize total opioid consumption converted as MME. The median total opioid consumption converted as MME for the pre-implementation group and the multimodal analgesia + VR group was 15.0 (*IQR* = 30.0) and 12.5 (*IQR* = 32.5) respectively (Table 6).

Table 6
Descriptive Statistics of the Primary Outcome Variable

						Shapiro-Wilk		
Variable	*N*	*M*	*SD*	*Mdn*	*IQR*	*W*	*df*	*p*

Opioid consumption	Pre	64	20.52	22.20	15.0	30.0	0.844	64	< 0.001
	MA + VR	22	21.00	24.48	12.5	32.5	0.836	22	0.002

The results of the Mann-Whitney *U* tests are presented in Table 7. For the comparison between pre-implementation and multimodal analgesia + VR, the results of the Mann-Whitney *U* test indicated that there was no statistically significant difference in total opioid consumption converted as MME between pre-implementation and multimodal analgesia + VR (*U* = 686.50, Z = -0.176, *p* = 0.860, *r* = 0.019; Table 7). The median total opioid consumption converted as MME for the pre-implementation group and the multimodal analgesia + VR group was 15.0 (*IQR* = 30.0) and 12.5 (*IQR* = 32.5), respectively (Table 6).

Table 7

Results of Mann-Whitney U tests for Differences in Total Opioid Consumption Converted as MME (Pre-implementation vs. MA + VR)

	N	*U*	*Z*	*p*	*r*
Pre vs. MA + VR	86	686.50	-0.176	0.860	0.019

Note. *U* = Mann-Whitney *U* test statistic; *z* = standardized test statistic; *p* = *p*-value. *r* = effect size, computed as $|z|/\sqrt{N}$, where *z* is the standardized test statistic and *N* is the number of total observations (Tomczak & Tomczak, 2014).

Discussion and Impact

This DNP project compared pre- and post-implementation data for 64 and 22 participants, respectively. A SMART goal outlined the project's aims—by providing virtual reality as a non-pharmacological intervention, can nurses decrease opioid exposure by 10% within the patient's recovery period? This project was unable to make a statistically significant impact on total opioid consumption in the PACU clinical setting. However, the analysis of system-wide effects discovered that nursing knowledge and experience with non-opioid

medications and VR technology improved—a change in practice that aligns with good clinical habits that can transfer to different patient environments (Allen et al., 2020).

Initially, the assumption was that an increase in multimodal analgesia and VR techniques would benefit the patient's surgical experience by lowering adverse opioid side effects. Although there wasn't a statistically significant decrease in opioids, the project guided the stakeholders to maintain patient-centered approaches. The patient customized their pain management care, provided feedback to the nurses about their preferred VR simulations, and decided whether to utilize the headsets after surgery as a pain management tool. As an added benefit, the nurses used the VR headsets in Pre-op to distract the patients during intravenous (IV) catheter insertions. In the study done by Glennon et al. (2018), VR technology was used as a distraction technique and decreased pain and anxiety levels during a bone marrow biopsy and aspiration procedure. Thus, further research is warranted to explore the effects of VR technology during percutaneous needle interventions.

The preoperative team demonstrated a significant change in practice during the implementation of this project. The post-implementation group of participants received multimodal analgesia 100% of the time, compared to almost a third of the time (32.8%) in the pre-implementation group. The data also revealed a remarkable difference in a separate group of participants not initially identified in the evaluation plan. In a group of 27 participants who received multimodal analgesia medications but refused to utilize the VR technology for numerous reasons, such as lethargy, nausea, and dizziness, the opioid consumption was substantially lower (13.59 MME) than the pre-implementation group (20.52 MME). Opioid consumption also decreased due to ERAS medications in the study done by Cozowics et al.

(2019). Therefore, this project recommends that multimodal analgesia be standard practice for all robotic hysterectomy patients undergoing same-day surgery.

Limitations

Various factors may have influenced the results. The evaluation plan included securing at least 64 participants in the post-implementation group. Unfortunately, this project occurred during the COVID-19 pandemic. Elective surgeries were canceled temporarily and approved to return right before the project start date. Therefore, the surgical volume of robotic hysterectomies was affected, negatively impacting program participants' ad hoc selection. The post-implementation group only included a total of 22 participants.

As previously mentioned, 27 participants refused VR technology in the PACU due to complaints of lethargy after general anesthesia, nausea, and dizziness. They also denied the VR headset if their pain was well managed—an unexpected barrier that hindered participant inclusion. Nurses did their best to minimize this limitation by promoting VR technology as a therapeutic intervention through patient education. However, anesthesiologists and nurses should consider altering their practice to reduce the aforementioned adverse effects. With the introduction of multimodal analgesia, clinicians may need to balance the administration of anesthetics and analgesics in addition to frontloaded pain management interventions.

Given the potential for significant improvement in pain management techniques, future EBP change projects may address using VR technology in other perioperative clinical settings, such as during the preoperative IV insertions or in lieu of anesthesia administration during minimally invasive procedures. Nursing practice should also mimic the best practices recommended. Furthermore, this project could be duplicated with an extended timeframe for data collection, ideally without outside factors influencing patient surgical volumes.

Plans for Dissemination

Plans for regional dissemination of this DNP project began in the fall of 2020. On Friday, October 9th, 2020, the DNP student presented at the organization's first annual Virtual Reality Symposium hosted by the hospital's Director of Extended Reality and Digital Therapeutics. The symposium's objectives focused on translational and implementation science and methods to incorporate innovative technologies at the clinical bedside. Virtual reality industry leaders, various community hospital executives interested in leading technology and potential organization donors were present at this meeting. The DNP student's goals included presenting the results and outcomes of the DNP project and acting as a nursing leader in the transforming field of virtual reality.

Organizational dissemination of the final DNP project started in November 2020. The DNP student created educational content for the Acute Care Nursing Conference. Presentations and educational material were organized according to the audience members in attendance and included information on practice transformation within the perioperative setting.

The national plan for dissemination included submitting an abstract for podium session at the Western Institute of Nursing (WIN) Conference and for a poster presentation at the Association of peri-Operative Registered Nurses (AORN) Global Surgical Conference & Exposition. Abstract submissions occurred during October 2020. The WIN Conference is held in Salt Lake City from April 14-17, 2021. The abstract considerations are expected by the beginning of the 2021. The AORN Global Surgical Conference & Exposition is scheduled for August 7-11, 2021 in Orlando, Florida. Abstract determinations may be considered during the spring season.

Although several plans were in place for dissemination, the DNP student built the capacity for change and adaptation as the novel coronavirus impacted society. Dependent on the recommendations from the CDC, conferences with large gatherings were prohibited. Therefore, strategies for dissemination shifted to webinar-based platforms, digital posters, and online journal publications. As a university requirement, a full-text scholarly publication is available in the University of St. Augustine for Health Sciences institutional repository called SOAR@USA.

Conclusion

The Multimodal Analgesic Virtual Reality Program's intended purpose was to provide a formative answer to society's opioid epidemic by reducing immediate postoperative opioid exposure and usage. Healthcare providers had the chance to positively influence the crisis by providing patients with evidence-based treatments and best practices for substance abuse prevention (Naegle, Mitchell, Flinter, Dunphy, Vanhook, & Delaney, 2017). Nurses, anesthesiologists, and surgeons worked together on this project to support the combination of non-opioid, multimodal analgesia and VR as a non-pharmacological intervention. This project focused on an opioid-sparing culture and required a coordinated, interdisciplinary team effort to change actions and policies.

Using the Model for Improvement, the DNP student acted as the nursing project lead and drove juxtaposed evidence-based practice changes along a timeline. The PDSA cycle ran from October 2019 to December 2020 and provided the rapid cycle culture change agenda. Numerable variables measured pre- and post-implementation of the program to capture if the healthcare providers' variation in practice contributed to the project's success.

There was no statistically significant difference in total opioid consumption converted as morphine milligram equivalents (MME) between the pre-implementation and post-

implementation groups. However, there was a statistically significant difference in multimodal analgesia administered in Pre-op between the pre-implementation and post-implementation groups. Therefore, the execution of the multimodal analgesic VR program allowed for nursing adoption of novel evidence-based practices (EBP) and promoted the use of non-opioid and non-pharmacological interventions. Although the combination of multimodal analgesia and VR did not reduce opioid consumption, the practice of incorporating multimodal analgesia as a standard workflow improved.

In conclusion, this project helped mitigate the potential for opioid abuse by providing clinicians other proven methods to treat pain effectively. A formal plan for disseminating its results was in place to attract buy-in from stakeholders within the organization and improve scalability to other nursing departments. The long-term objective remains active at the nursing bedside. Clinicians continue to adopt EBPs into their everyday workflow and pave the way for safe, quality care for patients exposed to opioids in the perioperative setting.

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Figure 1.

PRISMA Flow Diagram

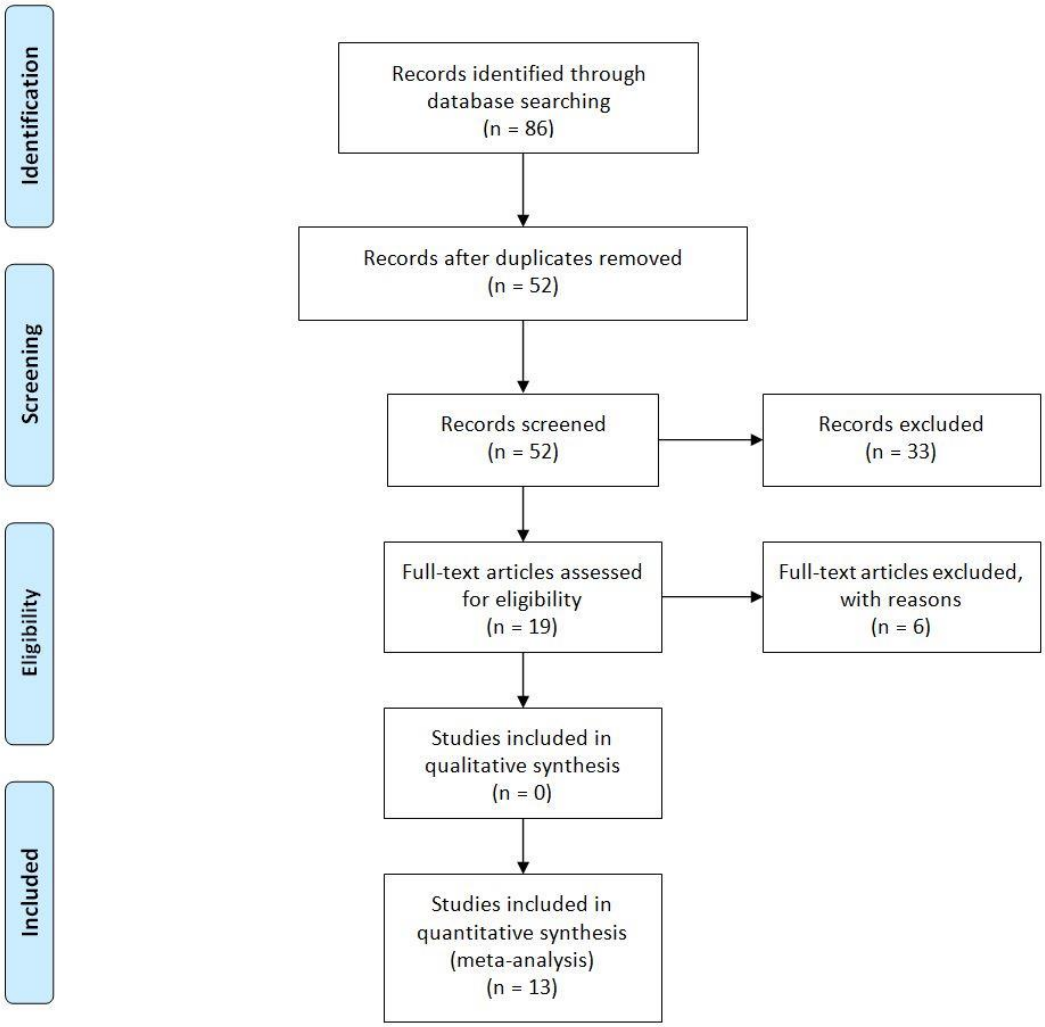

Figure 2.

Practice Recommendations Venn Diagram

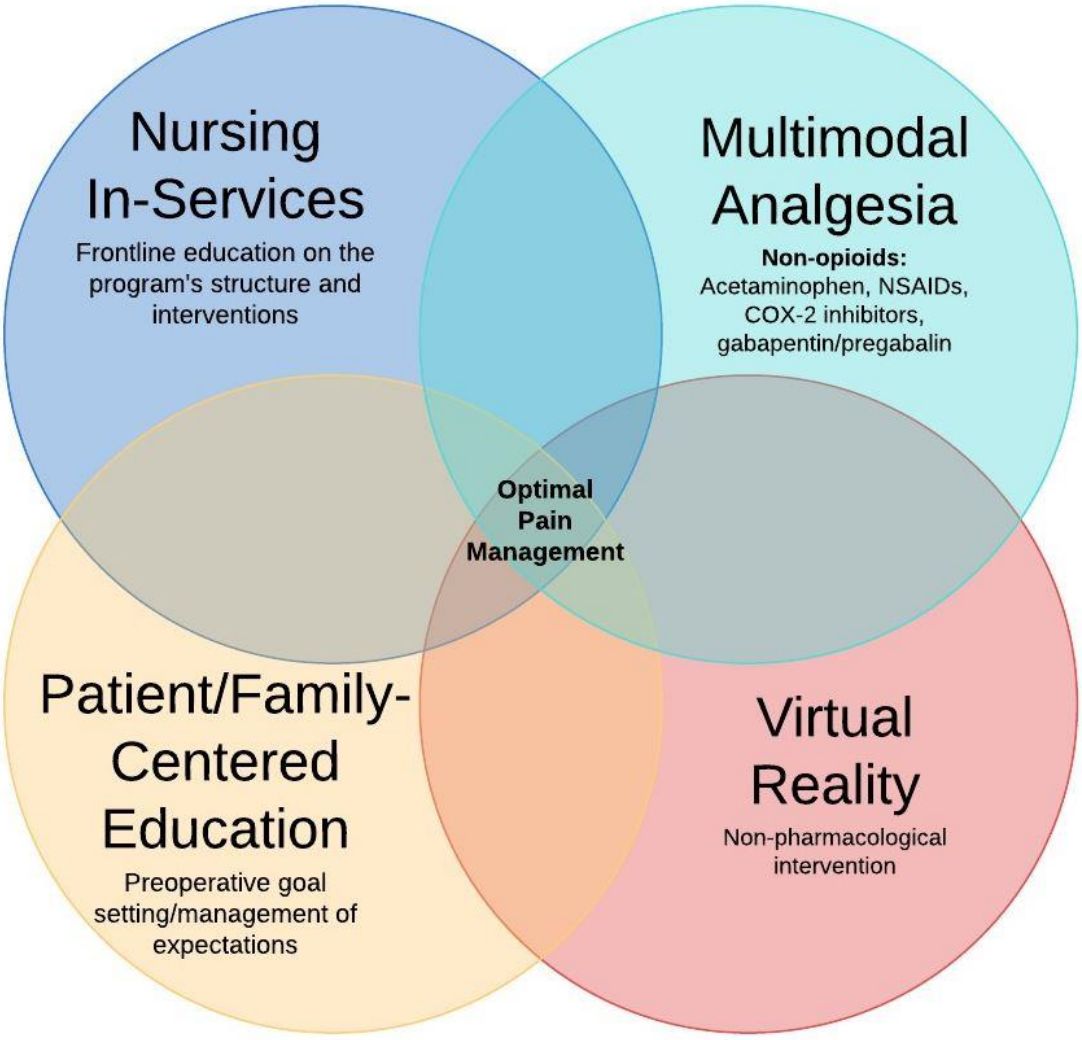

Figure 3.

SWOT Analysis

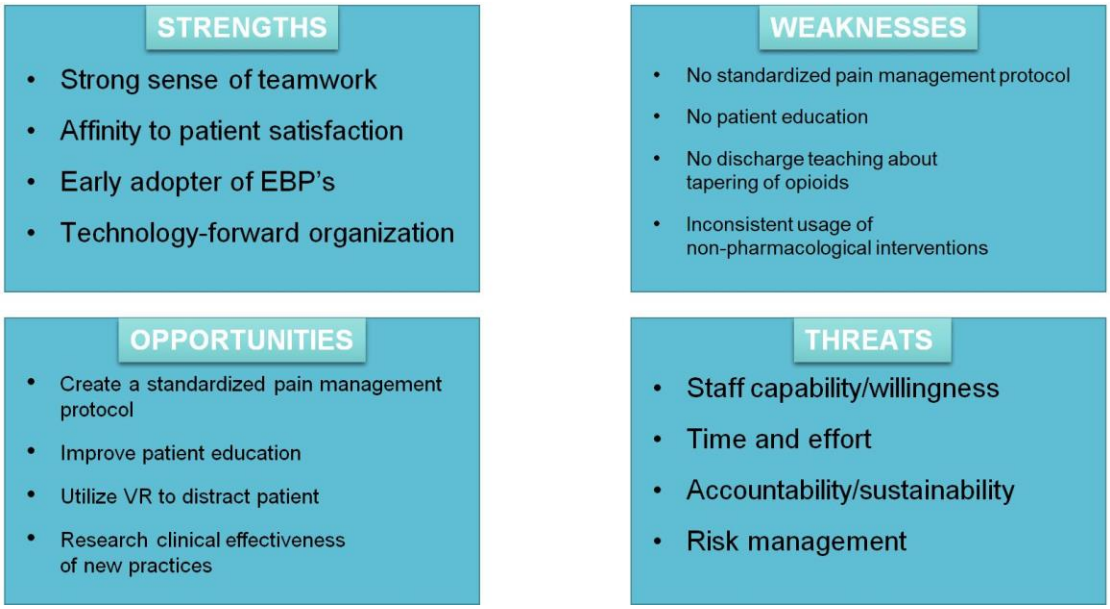

Figure 4.

Risk Assessment

	Risk	Impact	Probability	Score
1	Technology Hazard - Virtual Reality (VR) Headset Malfunction	1	2	2
2	Disruption of Nursing Workflow	2	3	6
3	Nursing Dissatisfaction with VR	2	2	4
4	Patient Dissatisfaction with VR	2	2	4
5	Transfer of Infectious Diseases from VR Headsets	3	2	6
6	Nausea and/or Vomiting with VR Headset	3	4	12
7	Patient Delayed Discharge from Mismanaged Pain	3	3	9
8	Patient Cognitive Disorientation/Delirium with VR Headset	4	3	12
9	Patient Fall with VR Headset On	4	3	12
10	Nurse Fall during VR Headset Calibration	4	3	12
11	User Experiences Seizure During Usage	4	1	4
12	Electrocution from Cleaning Solution Coming in Contact with Electric Components on VR Headset	4	2	8

Figure 5.

Project Budget

Project Name	VR Project		**Project Number**	**Scope Date**	Jan-Dec 2020
Project Sponsor	Dr. Robert Louis		**Title**	"A Multimodal Analgesic Virtual Reality Program to Reduce Opioid Exposure and Usage"	
Sponsoring Department	HHNB PACU		**Project Manager**	Jessica Jose	
Project Costs					
				One-Time Costs	$39,047.53
				Estimated Annual Ongoing Operating Costs	$18,000.00
				Total Project Costs	$57,047.53
One-Time Costs					
Hardware	QTY	Price	Tax?	Comments	**Total Cost**
All-in-one VR Headset	6	700	Y	Applied VR Estimate 32779-1	$4,200.00
Cleanbox Technology/Portable Cart/Chargers	1	10,000	Y		$10,000.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
Sub-Total					$14,200.00
Sales Tax	*7.75%*				$1,100.50
Shipping / Handling Fee					$0.00
Hardware Sub-Total					**$15,300.50**
Software	QTY	Price	Tax?	Comments	**Total Cost**
Healthcare VR Subscription Plan (1 year)	6	3,000	N	Software License + Tech Support	$18,000.00
Research Discount	6	-500	N		-$3,000.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
Sub-Total					**$9,510.00**
Sales Tax	*7.75%*				$737.03
Shipping / Handling Fee					$0.00
Software Sub-Total					**$10,247.03**
Purchased Services		Quantity		Comments	**Total Cost**
Educational Material for Nursing Class & Patients		1			$500.00
Purchased Services Sub-Total					**$500.00**
Training Services		Quantity		Comments	**Total Cost**
2 Hour Class * 100 Nurses	2	6,500		$65/hr * 100 = $6500	$13,000.00
Training Services Sub-Total					**$13,000.00**
Ongoing Operating Costs					
Annual Expenses				Comments	**Total Cost**
Healthcare VR Subscription Plan (1 year)					$18,000.00
Ongoing Operating Sub-Total					**$18,000.00**

Figure 6.

Process Map Algorithm for VR Headset Criteria

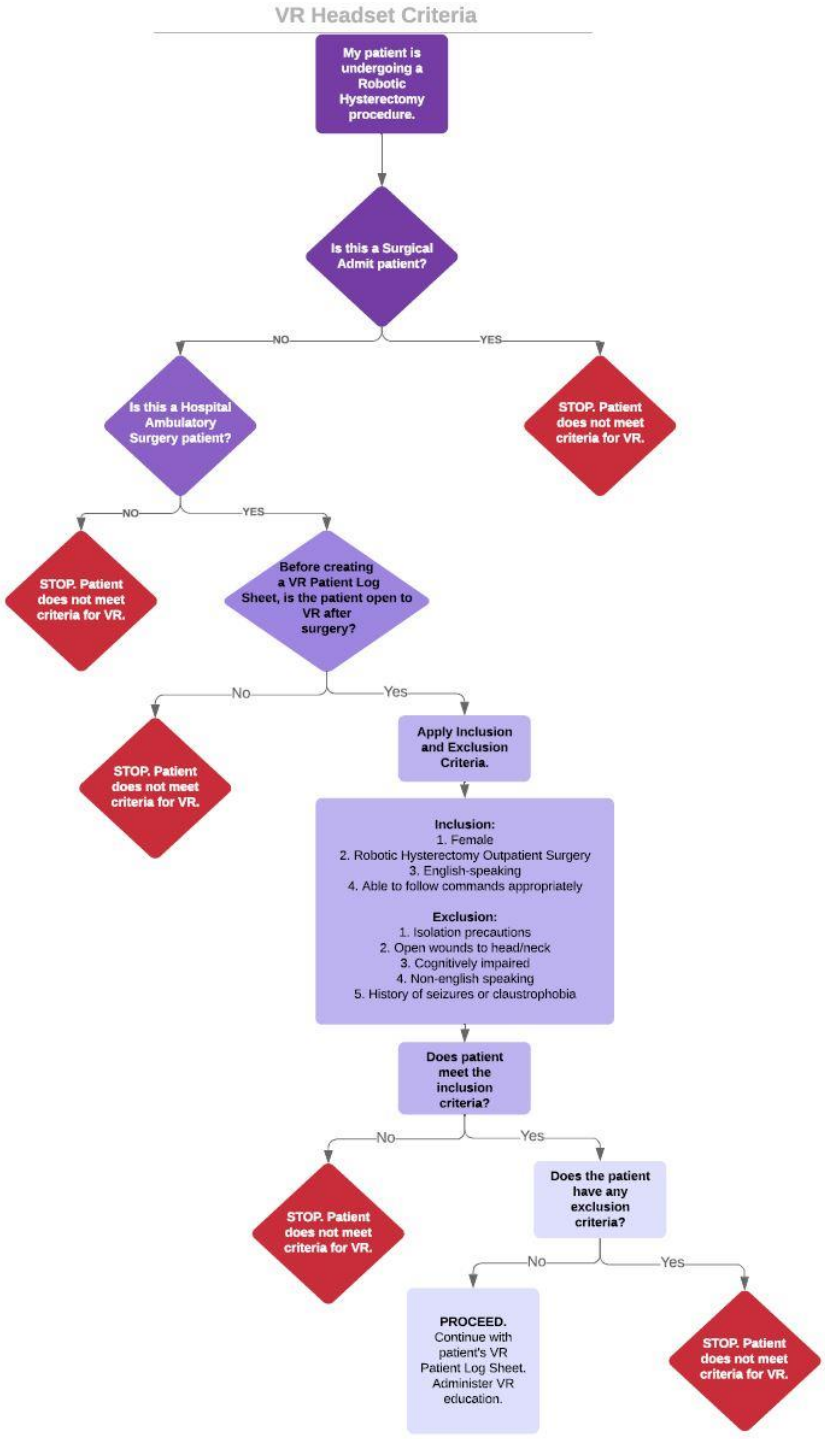

Figure 7.

SootheVR Instruction Pamphlet

soothe^VR

Drug-Free Pain Care

Developed for discreet, repeated use in high volume clinical settings. Each **SootheVR** system comes with a Pico G2 4K virtual reality headset preinstalled with 40+ immersive modules.

OUR THERAPEUTIC VR PLATFORM

Evidence-Based Content on Demand

- 40+ calming and interactive immersive experiences
- Incorporates cognitive behavioral therapy and biofeedback technology
- Developed using an evidence-based approach in partnership with psychologists, patients, doctors, researchers, and designers

CONTENT CATEGORIES

Escape

Calming escapes let you explore new worlds

Relax

Relaxing experiences guide you through mindful exercises

Guided

Biofeedback technology brings your breath to life in VR

HARDWARE

- High resolution 4K screen
- Wipeable face pad
  Meets infection control standards: Care and cleaning instructions developed with top medical institutions and are in line with the Center for Disease Control's (CDC) Infection Control Guidance.[4]
- Custom Amplifier to help visualize your breath

SOFTWARE

- Hands-free, gaze-based control
- On-demand access with content recommendation engine
- Provides an escape for people experiencing anxiety, stress, and pain

SEVEN STAR SERVICE AND SUPPORT

Every order includes virtual and onsite onboarding and implementation support from AppliedVR's customer success team.

ORDER INFO

Product Number	Description
W-STH-2001	**SootheVR** – all-in-one therapeutic VR platform for people experiencing anxiety.

*The published evidence has not been reviewed by the FDA. References: 1. Spiegel B, Fuller G, Lopez M, Dupuy T, Noah B, Howard A, et al. (2019 Virtual reality for management of pain in hospitalized patients: A randomized comparative effectiveness trial. PLoS ONE 14(8): e0219115. https://doi.org/10.1371/journal.pone.0219115 2. Sikka N, Shu L, Ritchie B, Amdur RL, Pourmand A. Virtual Reality-Assisted Pain, Anxiety, and Anger Management in the Emergency Department. (2019). Telemed J E Health. = doi: 10.1089/tmj.2018.0273 3. Gold, JI., Mahrer, NE. Is Virtual Reality Ready for Prime Time in the Medical Space? A Randomized Control Trial of Pediatric Virtual Reality for Acute Procedural Pain Management. (2018). J Pediatr Psychol. 2018 Apr 1;43(3):266–275. doi: 10.1093/jpepsy/jsx129. https://www.ncbi.nlm.nih.gov/pubmed/29053848 4. https://www.cdc.gov/sars/guidance/i-infection/healthcare.html

Patients in hospitals around the world have experienced the calming effects

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Figure 8.

World Health Organization Pain Relief Ladder & Nursing Pain Management Framework

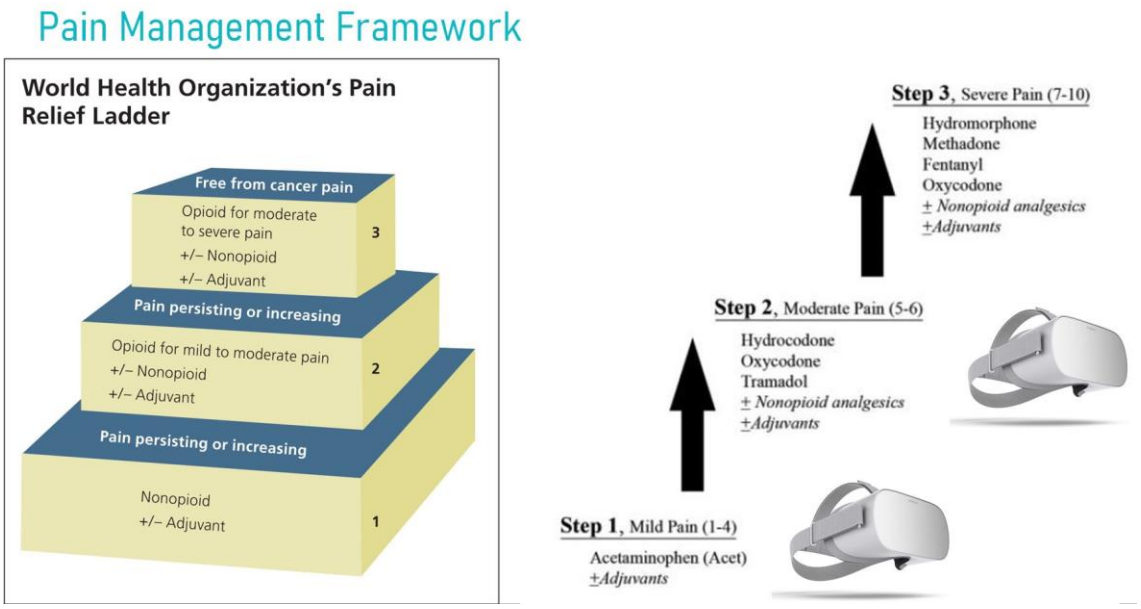
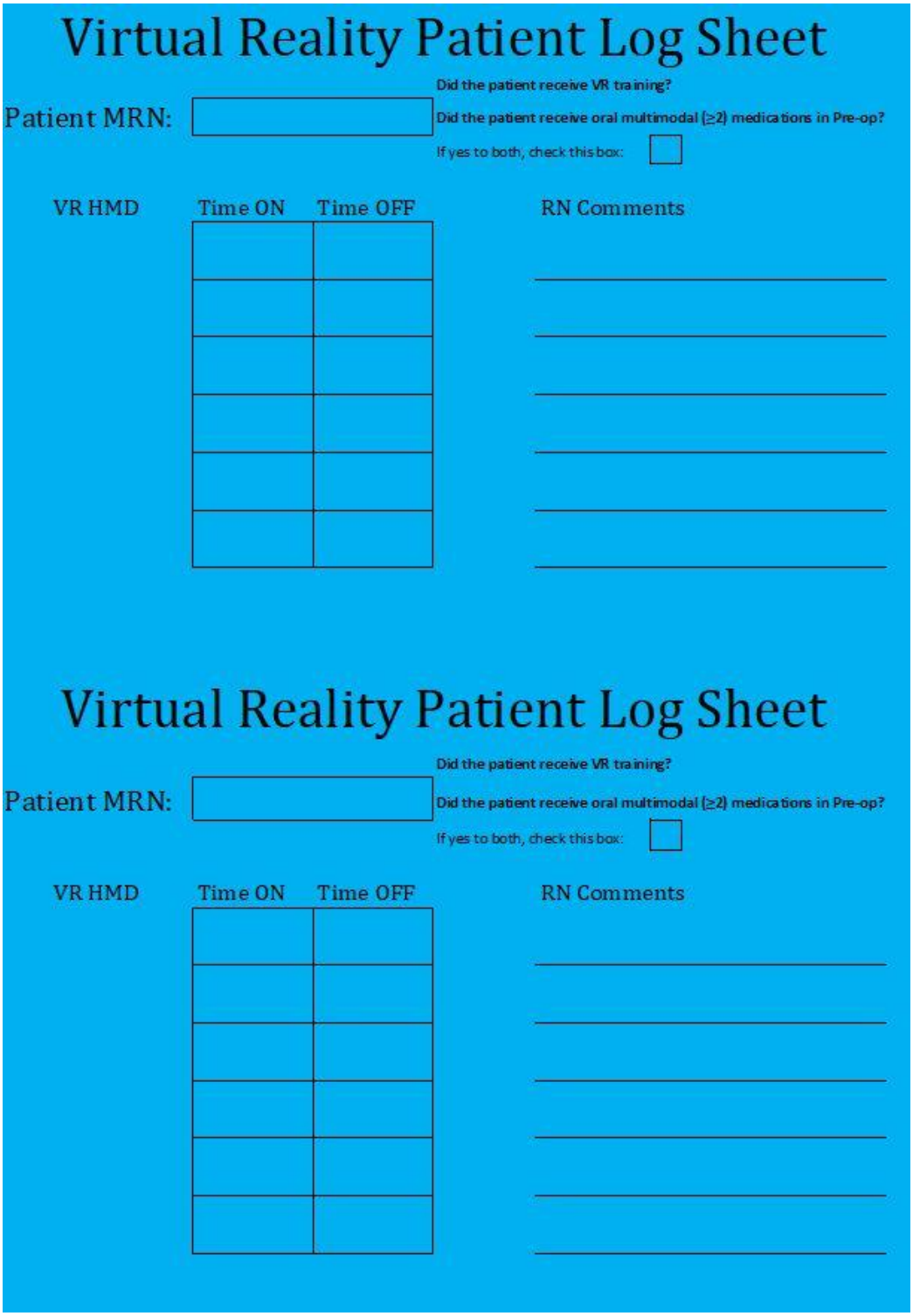


Figure 9.

Virtual Reality Patient Log Sheet



Appendix A

Table 1. Primary Research Evidence Table

Citation	Question or Hypothesis	Theoretical Foundation/ Conceptual Framework	Research Design	Key Findings	Recommendations/ Implications	Level of Evidence/Quality
Brandal, D., Keller, M. S., Lee, C., Grogan, T., Fujimoto, Y., Gricourt, Y., … Cannesson, M. (2017). Impact of enhanced recovery after surgery and opioid-free anesthesia on opioid prescriptions at discharge from the hospital: A historical-prospective study. *Anesthesia & Analgesia*, *125*(5), 1784–1792. doi: 10.1213/ane.0000000000002510	For patients undergoing colorectal surgery, are they less likely to receive opioid prescriptions if an ERAS/multimodal analgesic/opioid-free protocol was put in place?	None	Historical-prospective study, pre- and post-implementation design (n=200) t-test and α^2 test	Implementation of an ERAS intervention for colorectal surgery showed a statistically significant difference in the administration of intraoperative and postoperative morphine equivalents consumption. There was no impact on prescriptions for opioids on discharge.	Physician behavior is the crux of opioid prescribing practices, which is unrelated to the patient's need for a prescription after surgery. The perioperative period exposes the opportunity to prevent chronic opioid usage when treating acute pain. Modifying interventions to increase opioid-free anesthesia and multimodal analgesia can impact the opioid epidemic.	V/Good
Cozowicz, C., Poeran, J., Zubizarreta, N., Liu, J., Weinstein, S., Pichler, L., … Memtsoudis, S. (2019). Non-opioid analgesic modes of pain management are associated with reduced postoperative complications and resource utilisation: a retrospective study of	The addition of non-opioid analgesics will reduce opioid consumption and other adverse effects in patients undergoing	None	Retrospective cohort study (n = 181,182) χ^2 test, Kruskal-Willis test, multilevel, multivariable	Commonly utilized non-opioids included paracetamol/ acetaminophen, NSAIDs, COX-2 inhibitors, and gabapentin/pre-gabalin, followed	Multimodal analgesia is beneficial for reducing a number of different adverse effects as a result of opioid usage. It also reduces LOS, cost, and gastrointestinal complications.	III/High

obstructive sleep apnoea patients undergoing elective joint arthroplasty. *British Journal of Anaesthesia*, *122*(1), 131–140. doi: 10.1016/j.bja.2018.08.027	lower extremity joint arthroplasty surgery with a history of OSA.		regression models (logistic and linear regression for binary and continuous outcomes, respectively)	by peripheral nerve blocks, ketamine, and steroids. This study showed a reduction in PCA usage and postoperative ventilation as multimodal analgesics increased. For patients who only received opioids, LOS, cost, and complications were the highest. An individual analysis of non-opioid medications showed COX-2 inhibitors and NSAIDs to be most effective for opioid reduction.		
Desai, K., Carroll, I., Asch, S. M., Seto, T., Mcdonald, K. M., Curtin, C., & Hernandez-Boussard, T. (2018). Utilization and effectiveness of multimodal discharge analgesia for postoperative pain management. *Journal of Surgical Research*, *228*, 160–169. doi:	This study wanted to find out: (1) are multimodal guidelines being followed, (2) how effective were the guidelines for	None	Retrospective cohort study (n = 42,474) Descriptive statistics, α^2 test, Fisher exact test, analysis of	Most patients within the study received drug combinations (i.e. opioids and acetaminophen), but a larger majority received only opioids. Multimodal	Increasing clinical awareness of improved pain management guidelines can lead to less opioid usage. This study shows how applying multimodal regimens to multiple surgical specialties can	III/High

10.1016/j.jss.2018.03.029	postoperative pain, and (3) what are the long-term benefits?		variance, hierarchical logistic regression models	therapy (opioids, acetaminophen, and NSAIDs) was associated with lower pain scores and decreased readmissions compared with opioids alone.	enhance pain outcomes.	
Glennon, C., Mcelroy, S., Connelly, L., Lawson, L. M., Bretches, A., Gard, A., & Newcomer, L. (2018). Use of virtual reality to distract from pain and anxiety. *Oncology Nursing Forum*, *45*(4), 545–552. doi: 10.1188/18.onf.545-552	Can virtual reality reduce pain and anxiety in patients undergoing bone marrow aspiration and biopsy procedure?	An individual's perception of pain can be reduced by distracting their attention away from the stimulus.	Quasiexperimental research design (n = 97) t-test, α^2 test	Virtual reality did not contribute to a decrease in pain and anxiety during bone marrow aspiration and biopsy. However, there was a difference in pain and anxiety pre- and post-intervention.	Virtual reality is a non-pharmacological measure with minimal side effects that can be employed for its distractive technique to reduce pain and anxiety.	II/Good
Militsakh, O., Lydiatt, W., Lydiatt, D., Interval, E., Lindau, R., Coughlin, A., & Panwar, A. (2018). Development of multimodal analgesia pathways in outpatient thyroid and parathyroid surgery and association with postoperative opioid prescription patterns. *JAMA Otolaryngology–Head & Neck Surgery*, *144*(11), 1023. doi: 10.1001/jamaoto.2018.0987	Does offering multimodal analgesic pathways affect opioid prescriptions at discharge after thyroid and parathyroid surgery?	None	Cohort study, retrospective review (n = 528) Pearson χ^2 test	This study found that as MMA administration (NSAIDs, gabapentin, acetaminophen) increased, only a few patients required opioid prescriptions at discharge.	As clinicians adhered to the new MMA protocol, there was a progressive decline in required opioid prescriptions prior to discharge. Strategies to change clinician culture to steer away from opioids and their adverse side effects is needed.	V/Good

Mohammad, E. B., & Ahmad, M. (2018). Virtual reality as a distraction technique for pain and anxiety among patients with breast cancer: A randomized control trial. *Palliative and Supportive Care*, *17*(1), 29–34. doi: 10.1017/s1478951518000639	Is there a difference between standard pain management (oral and IV morphine) and standard pain management with VR in patients with chronic pain from breast cancer? Also, is there a difference in anxiety levels?	None	Randomized control trial design (n = 80) Independent sample t-test	A significant reduction in pain and anxiety was found in this study. Adding VR to morphine administration more effectively managed pain compared to morphine administration alone. Participants in this study did not experience any unusual side effects when using VR.	VR is an effective non-pharmacologic, distractive intervention that can be utilized by nurses without a doctor's order. It has been shown to decrease both pain and anxiety in breast cancer patients.	I/Good
Spiegel, B., Fuller, G., Lopez, M., Dupuy, T., Noah, B., Howard, A., … Danovitch, I. (2019). Virtual reality for management of pain in hospitalized patients: A randomized comparative effectiveness trial. *Plos One*, *14*(8). doi: 10.1371/journal.pone.0219115	Is there a difference between VR intervention versus "health and wellness" television programming in the inpatient setting for patients in pain?	None	Randomized comparative effectiveness trial (n = 120) Shapiro-Wilk test, t-test, linear regression analysis, multilevel mixed model regression analysis	There was a statistically significant improvement in pain for patients who utilized VR during their hospital stay versus the "health and wellness" TV channel. Patients also reported higher satisfaction with the VR intervention.	VR is a complementary intervention to traditional pain management. It is an effective tool that can be used to manage inpatient pain.	III/High

				There was no difference in total opioid administration, but pain was better controlled.		
Smith, A. M., Young, P., Blosser, C. C., & Poole, A. T. (2019). Multimodal stepwise approach to reducing in-hospital opioid use after cesarean delivery. *Obstetrics & Gynecology*, *133*(4), 700–706. doi: 10.1097/aog.0000000000003156	Can the implementation of a quality improvement program to eliminate scheduled opioids and only offer them on an as-needed basis, reduce opioid use in cesarean delivery patients?	None	Retrospective cohort study, pre- and post-implementation design (n=569) t-test, Mann Whitney U, and Pearson correlation coefficient, multivariable logistic regression	There was a significant reduction of morphine milligram equivalents post-intervention and a subsequent increase in acetaminophen use per day. There was no difference in measured pain scores or lengths of stay.	Utilizing a stepwise approach to multimodal analgesia (combining non-opioid and oral opioid medications) contributes to better pain management and fewer side effects. By shifting the culture away from scheduled opioids to as-needed administration, along with scheduled acetaminophen and NSAIDS, patients undergoing cesarean deliveries used opioids less without any changes to reported pain.	V/Good
Vázquez, J. L. M., Lara, D. M., Lara, J. L. M., Miller, I., Wiederhold, M. D., & Wiederhold, B. K. (2019). Pain distraction during ambulatory surgery: Virtual reality and mobile devices. *Cyberpsychology, Behavior, and Social Networking*, *22*(1), 15–21.	Can mobile phones, free smartphone apps, and inexpensive VR headsets be more effective than HMDs and	None	Non-experimental correlational research (n = 44) Descriptive statistics, *F*	A reduction in pain was seen both intraoperatively and postoperatively for patients who used both HMDs and Mobile	Mobile applications offer a less expensive, less immersive VR technology that can benefit pain during and after surgery. HMDs are required for more prolonged or invasive surgeries,	III/Low

doi: 10.1089/cyber.2017.0714	VEs in decreasing surgical pain?		test, Z test	applications. Patients using HMDs saw a greater decrease in pain postoperatively.	contrary to lipoma removals.	

Legend:

ERAS – Enhanced recovery after surgery

HMD – Head-mounted display

IV – Intravenous

LOS – Length of stay

MMA – Multimodal analgesia

OSA – Obstructive sleep apnea

NSAIDs – Nonsteroidal anti-inflammatory drugs

TV – Television

VE – Virtual environment

VR – Virtual reality

Appendix B

Table 2. Summary of Systematic Reviews (SR)

Citation	**Level of Evidence / Quality Grade**	**Question**	**Search Strategy**	**Inclusion/ Exclusion Criteria**	**Data Extraction and Analysis**	**Key Findings**	**Usefulness/ Recommendation/ Implications**
Brubaker, L., Kendall, L., & Reina, E. (2016). Multimodal analgesia: A systematic review of local NSAIDs for non-ophthalmologic postoperative pain management. *International Journal of Surgery*, *32*, 158–166. doi: 10.1016/j.ijsu.2016.07.003	I/Good	To analyze the role of NSAIDS in non-ophthalmologic postoperative pain management.	Electronic databases: PubMed MEDLINE, Cochrane Central Register of Controlled Trials (CENTRAL)	Inclusion criteria: Randomized controlled studies comparing NSAIDs and standard procedures/placebo Exclusion criteria: No comparison or comparison group received intramuscular NSAIDs, as opposed to IV or oral.	Independent screening yielded 142 studies. 9 RCTs were included. Risk of bias was assessed using the Cochrane Risk of Bias instrument. Overall quality was measured using the GRADE approach.	Low to moderate quality evidence supporting the use of NSAIDs both preoperatively and postoperatively in addition to standard post-surgical pain management. Low to moderate quality evidence that NSAID administration improves function.	Standardized administration methods for NSAIDs lacks within research. Unable to make a summary statement due to a small number of RCTs. Further research is required for recommendations regarding safer, cost-effective interventions.
Mallari, B., Spaeth, E. K., Goh, H., & Boyd, B. S. (2019).	I/Good	To compare the effectiveness on VR in adults with both acute and chronic pain	Electronic databases: TRIP, CINAHL, MEDLINE (via PubMed)	Inclusion criteria: "immersive" VR, English articles, dated January 2007 to December 2018, adults ≥ 18 years old,	Two researchers identified 485 articles. Total of 20 articles were included; 14 RCTs,	VR is an effective tool to reduce acute pain during various medical procedures. There are inconsistent	Pain intensities can be reduced with VR when patients have acute pain. Recommendations

Citation	Level of Evidence / Quality Grade	Question	Search Strategy	Inclusion/ Exclusion Criteria	Data Extraction and Analysis	Key Findings	Usefulness/ Recommendation/ Implications
Virtual reality as an analgesic for acute and chronic pain in adults: a systematic review and meta-analysis. *Journal of Pain Research, Volume 12*, 2053–2085. doi: 10.2147/jpr.s200498				pain intensity as the outcome measure Exclusion criteria: "nonimmersive" VR, nonexperimental studies, experimental pain, studies published before 2007	6 quasiexperimental studies. The PEDro tool was used to analyze risk of bias for RCTs. The Modified Downs and Black (MD&B) quality index was applied to nonrandomized studies.	findings for pain reduction in patients with chronic pain.	include evaluating the cost-effectiveness of VR as an adjunctive pain tool.
Scapin, S., Echevarría-Guanilo, M. E., Junior, P. R. B. F., Gonçalves, N., Rocha, P. K., & Coimbra, R. (2018). Virtual reality in the treatment of burn patients: A systematic review. *Burns, 44*(6),	II/Good	To identify the main effects of virtual reality for burn patients.	Electronic databases: LILACS, BDENF, SciELO, CINAHL, Web of Science, PubMed/MEDLINE, SCOPUS, Academic Search Complete, PsycINFO	Inclusion criteria: Complete works included, such as original articles and case reports Exclusion criteria: Revisions, letters, reviews, editorials, and duplicate studies	34 studies analyzed; 23 RCTs, 3 controlled and non-randomized clinical trials—level of evidence based on the Cochrane classification.	VR is an effective tool for managing both psychosocial and neurosensitive factors related to pain. VR has demonstrated, on magnetic resonance imaging, reduced activation of CNS pain regions in the brain. VR also works as a distraction mechanism, deviating the user's focus away from pain, thus reducing the need for medication.	VR is a proven, effective non-pharmacological intervention for pain in burn patients. It also benefits other consequences of pain, such as anxiety.

Citation	Level of Evidence / Quality Grade	Question	Search Strategy	Inclusion/ Exclusion Criteria	Data Extraction and Analysis	Key Findings	Usefulness/ Recommendation/ Implications
1403–1416. doi: 10.1016/j.burns.2017.11.002							
Chan, E., Foster, S., Sambell, R., & Leong, P. (2018). Clinical efficacy of virtual reality for acute procedural pain management: A systematic review and meta-analysis. *PLos One*, *13*(7). doi: 10.1371/journal.pone.0200987	II/High	Comprehensively assess the efficacy of virtual reality as a pain intervention.	Electronic databases: Cochrane Library, Ovid MELINE, Embase, CINAHL, ERIC, NIHR Centre for Review and Dissemination, Proquest	Inclusion criteria: Peer-reviewed journal, examined effect of VR on acute pain, measured pain scores Exclusion criteria: Lacked intervention for pain, non-VR control group, and experimental design	48 full text articles found; 11 RCTs, 9 crossover studies, 20 qualitative syntheses. Cochrane risk of bias assessment tool was used for parallel group RCTs. The tool was modified for crossover trials.	The meta-analysis conducted showed that VR had a positive influence on pain scores. However, its effects vary between different procedures, where needle studies and burn physical therapy showed the most benefit. Since VR is a non-blindable intervention, bias was present throughout the review.	Early evidence suggests that VR is effective for treating pain during burn physical therapy and needle studies. There is a need for higher-quality studies to validate the widespread adoption of VR.

Legend:

BDENF – *Base de Dados de Enfermagem*

CINAHL – Cumulative Index to Nursing & Allied Health Literature

CNS – Central nervous system

GRADE – Grading of Recommendations Assessment, Development and Evaluation

LILACS – Latin American and Caribbean Health Sciences Literature

RCT – Randomized control trial

TRIP – Turning Research into Practice

SciELO – Scientific Electronic Library Online

Appendix C

Project Schedule

	NUR7801								NUR7802								NUR7803							
Activity	Week 1	Week 3	Week 5	Week 7	Week 9	Week 11	Week 13	Week 15	Week 1	Week 3	Week 5	Week 7	Week 9	Week 11	Week 13	Week 15	Week 1	Week 3	Week 5	Week 7	Week 9	Week 11	Week 13	Week 15
Meet with preceptor and project champions	X																							
Needs assessment/practice gap analysis	X	X																						
Create a project budget	X																							
Seek Executive Leadership Approval		X																						
Conduct literature review	X	X	X	X																				
Prepare project proposal	X	X	X	X	X	X	X	X																
Obtain project stakeholder approval								X	X	X	X	X												
Obtain university EBP committee approval										X														
Obtain hospital IRB approval										X														
Offer nursing education in-services										X	X													
Begin HMD test-run and document observations/ unexpected findings										X	X													
Begin project pilot implementation											X	X	X	X										
Begin data collection											X	X	X	X	X	X								
Comprehensive statistical analyses																	X	X	X					
Analyze efficacy of program																				X	X	X	X	X

	NUR7801								NUR7802								NUR7803							
Activity	Week 1	Week 3	Week 5	Week 7	Week 9	Week 11	Week 13	Week 15	Week 1	Week 3	Week 5	Week 7	Week 9	Week 11	Week 13	Week 15	Week 1	Week 3	Week 5	Week 7	Week 9	Week 11	Week 13	Week 15
Evaluate feasibility and sustainability of program																					X	X	X	X
Disseminate learning to organization																						X	X	X
Begin planning for next PDSA cycle																							X	X

Appendix D

Table 3. Evaluation Plan

	Variable Name	Variable Description	Data Source	Possible Range of Values	Level of Measurement	Categories of Measures	Timeframe for Collection
Population	Patient MRN	Unique assigned medical record number	EPIC	N/A	Nominal	N/A	Pre- and Post-intervention
	Age	Age at start of intervention	EPIC	18-100	Continuous	N/A	Pre- and Post-intervention
	Gender	Gender	EPIC	0 = male, 1 = female	Dichotomous	N/A	Pre- and Post-intervention
	Race/Ethnicity	Race/Ethnicity	EPIC	0 = White, 1 = Hispanic, 2 = Black, 3 = Asian, 4 = Other	Nominal	N/A	Pre- and Post-intervention
	BMI	Body Mass Index	EPIC	15-50	Continuous	N/A	Pre- and Post-intervention
	ASA	American Society of Anesthesiologists Classification	EPIC	I-IV	Ordinal	N/A	Pre- and Post-intervention
	Diagnosis	Diagnosis warranting procedure	EPIC	0 = Other, 1 = Cancer	Dichotomous	N/A	Pre- and Post-intervention
Event	Preoperative Pain Score	Pain number using validated screening tool reported prior to surgery	EPIC	0 = Low Pain (0-5), 1 = High Pain (6-10)	Nominal	Outcome	Pre- and Post-intervention
	Pain at Discharge	Pain number using validated screening tool	EPIC	0 = Low Pain (0-5), 1 = High Pain (6-10)	Dichotomous	Process, Balancing, Sustainability	Pre- and Post-intervention
	Multimodal Analgesia Administered in Pre-op	≥ 2 oral, non-opioid pain medications given in Pre-op	EPIC	0 = No, 1 = Yes	Dichotomous	Outcome, Process, Balancing, Financial, Sustainability	Pre- and Post-intervention
	LOS - PACU	Length of stay; Both Phase I and Phase II Combined in	EPIC	15-360	Continuous	Process, Balancing, Financial	Pre- and Post-intervention

		Minutes					
	VR Time	Total VR utilization time in minutes	Log Sheet	0-120	Continuous	Process, Sustainability	Pre- and Post-intervention
Primary Outcome Variable	Total Opioid Consumption	Opioids converted to oral morphine milligram equivalents (MME) administered in PACU Phase I & II until discharge	EPIC	0-100	Nominal	Outcome, Process, Balancing, Financial, Sustainability	Pre- and Post-intervention

Appendix E

Gpower Sample Size Calculation