An Educational Module Explaining the Utilization of the IPACK Block Technique to Decrease Postoperative Pain and Opioid Consumption in Total Knee Arthroplasty Patients: A Quality Improvement Project

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An Educational Module Explaining the Utilization of the IPACK Block Technique to Decrease Postoperative Pain and Opioid Consumption in Total Knee Arthroplasty Patients: A Quality Improvement Project

A DNP Project Presented to the Faculty of the Nicole Wertheim College of Nursing and Health Sciences, Florida International University

In partial fulfillment of the requirements for the Degree of Doctor of Nursing Practice

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Approval Acknowledged: _______________________________, DNP Program Director
Date: _________________________

Approval Acknowledged: _______________________________, DNP Program Director
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Abstract

Total knee arthroplasty (TKA) is a common surgery performed in the United States. It is effective in treating end-stage arthritis and improving quality of life; however, it is associated with significant postoperative pain. Adequate pain management in the postoperative period can be challenging for anesthesia providers. Recently, the infiltration of local anesthetic into the interspace between the popliteal artery and the capsule of the knee, known as the IPACK block, has gained increasing popularity as a promising peripheral nerve block (PNB) for TKA patients. Despite evidence of the efficacy of the IPACK block in TKA patients, it is not widely utilized among anesthesia providers. This quality improvement project assessed whether anesthesia providers would benefit from an educational module on the utilization of the IPACK block technique to decrease postoperative pain and opioid consumption in TKA patients. After receiving consent, eight anesthesia providers participated in this project. Participation involved a pretest, an online educational module, and a posttest. Results suggested that the educational module increased provider knowledge regarding the TKA patient population, regional techniques for TKA, how to perform the IPACK block, and the benefits of utilizing the IPACK block in TKA patients.

Keywords: total knee arthroplasty, infiltration of local anesthetic into the interspace between the popliteal artery and the capsule of the knee, IPACK block, adductor canal block, peripheral nerve block, postoperative analgesia
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Introduction

Problem Identification

Total knee arthroplasty (TKA) is the most common surgical procedure performed in the United States.\(^1\) It is effective in treating end-stage knee arthritis and improving quality of life but is associated with a painful recovery. Reports have indicated that extreme knee pain in the immediate postoperative period occurs in over half of TKA patients.\(^1\) Not only is postoperative pain management critical for patient satisfaction, but it is also fundamental for early mobilization, rehabilitation, and hospital discharge.\(^1\) It is understood that a multimodal analgesic approach through the use of regional anesthesia in conjunction with systemic medications is the ideal method to reduce pain in TKA patients. There is a constant debate, however, about which multimodal approach best achieves optimal pain control. Recently, the infiltration of local anesthetic into the interspace between the popliteal artery and the capsule of the knee, known as the IPACK block, has gained increasing popularity as a promising peripheral nerve block (PNB) for TKA.

Background

TKA is characteristically a surgery affecting the older population, with the average patient age being 68 years old.\(^2\) It is important to note the physiologic changes that occur with aging when tailoring an anesthetic plan for this patient population. Loss of brain weight and volume coupled with a decline in circulating neurotransmitters make this patient population more sensitive to anesthetics and more prone to postoperative delirium.\(^3\) Due to age-related changes, many patients that present for TKA have several comorbidities. A study conducted by Kremers et al. found that in addition to degenerative joint disease, 57% of TKA patients were also
managing chronic diseases including, but not limited to, hypertension, diabetes, obesity, valvular disease, chronic pulmonary disease, hypothyroidism, anemia, depression, and heart failure. These age-related physiologic changes necessitate anesthesia providers to tailor a meticulous and individualized anesthetic plan to decrease morbidity after TKA.

Historically, an anesthetic approach supported by the use of opioids for attenuation of pain has been the standard of care. Potent opioids, however, are linked to adverse outcomes, including postoperative nausea and vomiting (PONV), respiratory depression, constipation, misuse, abuse, and addiction. Such adverse effects are the impetus for an ideological shift to opioid-sparing and opioid-free anesthesia. Several anesthetic strategies decrease the use of opioids without compromising patient analgesia, including multimodal use of non-opioid analgesics, neuraxial anesthesia, PNBs, and local anesthetics. PNB has become a popular anesthetic technique used to decrease postoperative pain in TKA. PNB is appealing because it is associated with a decreased use of systemic anesthetics and analgesics that are associated with negative side effects.

**Scope of the Problem**

Chronic joint disease requiring total joint replacement is a common condition in the United States. With a prevalence rate of around 1.52%, the number of individuals that have had TKA is nearly 5 million people. Furthermore, data indicates that over 1 million TKA procedures are performed each year in the United States. As human life expectancy continues to rise, the annual prevalence of TKA volume is also predicted to increase. By 2030, the rate of TKA is expected to increase to over 3 million surgeries per year. Studies have projected that without a rise in incidence rates, the aging population alone will result in 7.4 million people living with TKA by 2030.
Consequence of the Problem

TKA is associated with significant postoperative pain. It has been reported that 60% of patients that receive TKA experience severe postoperative pain, and 30% experience moderate pain. Acute pain in TKA is accompanied by many adverse physiologic effects that can contribute to morbidity and mortality, such as delay in ambulation and the development of chronic pain. Delay in ambulation increases the risk of postoperative complications such as venous thromboembolism and arthrofibrosis. Furthermore, acute pain activates the sympathetic nervous system (SNS) releasing catecholamines and cortisol. The cardiovascular effects of the SNS response include increased heart rate, increased vascular resistance, increased myocardial contractility, and increased blood pressure. These effects increase myocardial oxygen demand and consumption. In patients with underlying cardiovascular or atherosclerotic disease, significant increases in myocardial oxygen consumption can be fatal, leading to cardiac dysrhythmias, angina, ischemia, and infarction. Acute pain can also affect the respiratory system. Unresolved pain can lead to decreased tidal volume, vital capacity, inspiratory capacity, and functional residual capacity. Pain related to shallow breathing can further cause atelectasis and pneumonia. In patients that have an underlying disease, such pulmonary compromise may cause significant hypoventilation and hypoxia. Adverse physiologic effects from inadequate pain management have been shown to prolong patient recovery, prolong hospital stay, and reduce patient satisfaction.

Historic literature reported that the average length of hospital stay for TKA patients was 23 days. Today, the average length of TKA hospital stay is 3.7 days. Advancements in technology and medicine have decreased the hospital length of stay; however, associated costs remain high. Kremers et al. found that the average hospital stay for TKA costs $15,673 with the
largest proportion of costs being room and board. Furthermore, patients that experience a hospital complication, such as uncontrolled pain, will incur a 34% increase in costs due to prolonged length of hospital stay. As the prevalence rates of TKA rise, the economic burden increases as well. The high incidence rate of TKA obligates providers to deliver high-quality anesthesia care. Adequate pain management will help decrease the length of hospital stay, reduce healthcare costs, and improve satisfaction for TKA patients.

Knowledge Gaps

There have been various PNB techniques for TKA described in the literature. First, to effectively block the pain pathways of the knee, it is imperative to understand the nerve innervation of the joint. The anteromedial aspect of the knee is innervated by branches of the femoral nerve, whereas the posterior aspect of the knee joint is innervated by branches of the sciatic nerve. The adductor canal block (ACB) and femoral nerve block (FNB) both block branches of the femoral nerve, providing excellent postoperative analgesia to the anterior and medial part of the knee but fail to anesthetize the posterior aspect of the joint. The sciatic nerve block (SNB) provides great analgesia to the posterior aspect of the knee but fails to anesthetize the anterior and medial aspects of the joint. The SNB is also associated with a profound motor blockade, which can be detrimental to early ambulation. Although beneficial, these PNBs are incapable of anesthetizing the knee joint in its entirety, necessitating supplemental analgesics to provide appropriate pain relief in TKA patients. Further research is needed to investigate the full scope of clinical benefits of the totality of regional anesthesia for TKA.

Proposal Solution

The novel IPACK block is a promising regional approach to reduce postoperative pain and improve surgical outcomes for TKA. The IPACK block aims to anesthetize branches of both
the sciatic nerve and the obturator nerve to provide analgesia to the posterior knee. It is an appealing technique because it blocks the sensory branches of the sciatic nerve while sparing motor function. Motor-sparing sensory blockade is ideal because it facilitates early ambulation, functional recovery, and hospital discharge. Due to its motor-sparing effects, studies have demonstrated that when added to the ACB, the IPACK block is associated with reduced postoperative pain and reduced opioid consumption in TKA. Despite the evidence supporting its use, the IPACK block is an underutilized intervention among anesthesia providers. Anesthesia providers would benefit from an educational module regarding the benefits and how to perform the IPACK block in TKA patients. This quality improvement project included a pretest, an educational module, and a posttest to assess understanding.

**Literature Review**

**Eligibility Criteria**

Studies evaluated for this literature review were assessed after strict inclusion and exclusion criteria were applied. Peer-reviewed, full text, randomized controlled trials (RCTs) completed within 5 years and written in the English language that compared the IPACK block and the ACB versus the ACB alone in TKA patients were eligible for review. Exclusion criteria included studies that were not RCTs, studies that were not peer-reviewed, studies greater than 5 years old, studies of a different language other than English, and studies that did not compare the IPACK block and the ACB versus the ACB alone in TKA patients.

**Search Strategy**

To investigate the literature, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, and ClinicalKey databases were accessed via the Florida
International University (FIU) remote online library. The keywords explored included (“interspace between the popliteal artery and capsule of the knee” OR IPACK) AND (“adductor canal” or “adductor canal block”) AND (“total knee arthroplasty” OR “total knee” OR TKA). The Boolean operators AND and OR were included to combine key concepts. Utilizing these search words, the CINAHL database produced 10 articles. After inclusion and exclusion criteria were applied, 2 articles were chosen for review. The PubMed database produced 7 results. After applying inclusion and exclusion criteria, 3 studies qualified for review. Out of the 3 articles produced, 2 were duplicates of the CINAHL database, and 1 additional article was appraised. Similar to PubMed, the ClinicalKey database produced 7 results. After inclusion and exclusion criteria were applied and duplicate studies were removed, 1 study was selected for review.

![Figure 1. Search Keywords](image-url)
Study Characteristics

The 5 articles selected for this literature review analyzed the use of the IPACK block in combination with the ACB compared to the ACB alone in TKA. Although each had various specific objectives, they all measured TKA patients’ postoperative pain scores and opiate consumption in some capacity. All studies reviewed were peer-reviewed RCTs published within the last 5 years. Well-designed RCTs are considered level 1 studies, which is the strongest form of evidence.

Results of Research Appraisal

Li et al., 2020

Li et al. designed this study titled “Efficacy of Adductor Canal Block Combined With Additional Analgesic Methods for Postoperative Analgesia in Total Knee Arthroplasty” to evaluate multiple PNB techniques for TKA patients. It was a single-center, prospective, double-blinded RCT that indicates a level 1 study with high-quality evidence. The abstract accurately summarized the background of the study, the methods utilized, and the results found. To
introduce the study, the authors thoroughly summarized a review of the current literature and discussed the importance of optimal analgesia for patient outcomes in TKA. Li et al. researched to evaluate the following PICO question: “Does blocking the sensory nerves that are distributed in the posterior and lateral aspect of the knee improve postoperative pain control?”

The authors thoroughly elaborated on their study methods. Inclusion criteria included patients aged 50 through 80, body mass index (BMI) of 19 through 30, and American Society of Anesthesiologists (ASA) classification of I through III. Exclusion criteria included the inability to walk; allergy to morphine; history of opioid consumption; patients with contraindications to anesthesia; diagnosis of sepsis, rheumatic arthritis, or traumatic arthritis; or history of mental illness, neuromuscular disorder, cerebrovascular accident, deep vein thrombosis, pulmonary embolus, and/or myocardial infarction. After inclusion and exclusion criteria were applied, computer-generated randomization separated 200 patients into 4 groups. The sample size far exceeded the authors’ goals of 0.85 power and 0.05 level of significance, which originally equated to 50 patients in each group.

The 4 groups were separated into specific interventions. Group A received ACB, lateral femoral cutaneous nerve block (LFCNB), and IPACK, Group B received ACB and IPACK, Group C received ACB and LFCNB, and Group D received ACB alone. All PNBs were performed under ultrasound guidance by a senior anesthetist utilizing 0.2% ropivacaine with 2mcg/mL of epinephrine, in addition to standardized postoperative care. The primary outcome measured pain scores utilizing the Visual Analog Score (VAS) and secondary outcomes measured opioid consumption. A p-value less than 0.05 was considered statistically significant. For this literature review, the comparison of Group B and Group D was evaluated.
Li et al. explained their outcomes in a detailed and systematic fashion. After analysis, the researchers found that patients in Group B had lower postoperative pain scores than Group D, both at rest and with activity, in all postoperative time categories including 2 hours, 8 hours, 12 hours, 24 hours, 48 hours, and at discharge. Statistical significance occurred in the following 4 categories: 8 hours at rest, 12 hours at rest, 2 hours with activity, and 8 hours with activity. Furthermore, Group B had less opioid consumption than Group D in all postoperative time categories measured including 0 to 24 hours, 24 to 48 hours, 48 hours to discharge, and total consumption. Statistical significance occurred at 24 hours and with the total consumption. It is also important to note that patients in Group B had a statistically significant longer analgesic duration of 17.9 hours, compared to the 13.09 duration that occurred in Group D.

The authors discussed 3 major limitations of this study. First, it was acknowledged that a larger sample size would be more beneficial. Additionally, the inability to objectively ensure all patients received the same quality of nerve blockade due to the individuality of each patient’s anatomy coupled with the skill variability of the anesthesia provider was recognized. Lastly, due to the strict inclusion criteria, it was unknown whether more patients would benefit from the various regional techniques. This study showed statistically significant and clinical benefits of the addition of the IPACK to the ACB in TKA. The authors recommended a need for further research to replicate similar results and for future studies to focus on long-term functional recovery.

Patterson et al., 2020

This study, titled “The Effect of the IPACK Block on Pain After Primary TKA,” was implemented to determine if the IPACK block provided any benefit to TKA patients. Patterson et al. formulated the following PICO question: “When used with ACB, what is the effect of the
IPACK block on pain, walk distance, and hospital stay in patients undergoing unilateral TKA?¹⁰

The authors utilized a single-center, prospective, double-blinded, randomized design making it a level 1 research study.

For this RCT, inclusion criteria included English-Speaking patients at least 18 years old with an ASA classification score of I through III. Exclusion criteria included allergy to local anesthetics and/or nonsteroidal anti-inflammatory (NSAID) agents, contraindications to regional anesthesia or PNB, chronic renal insufficiency, pre-existing peripheral neuropathy involving the operative site, and BMI greater than or equal to 40.¹⁰ After inclusion and exclusion criteria were applied, 69 patients were assigned to two groups utilizing a randomization generating tool. The sample size exceeded the authors’ goals of 0.8 power and 0.05 level of significance, which totaled 64 patients.

Using an adductor canal catheter, all patients received a continuous ACB. There were 35 patients assigned to the treatment group, known as the IPACK group, that received the continuous ACB and IPACK block. The 34 patients in the control group received the continuous ACB and a 2mL subcutaneous injection of normal saline. All PNB were performed under ultrasound guidance with 0.25% ropivacaine with 3mcg/mL epinephrine. All patients received the same standardized postoperative care. Furthermore, all patients and care providers were blinded to the group assignments, except for the regional anesthesia team that administered the peripheral nerve blocks. A p-value less than 0.05 was considered statistically significant.

Patterson et al. utilized an organized and detailed table to illustrate their results.¹⁰ Pain scores were reported via VAS, where 0 represented no pain and 10 represented the worst pain. The results indicated that patients that received the IPACK block had statistically significant lower pain scores at rest in the post-anesthesia care unit (PACU) than the control group.
Patterson et al. also found that the IPACK group had less pain during physical therapy in the PACU and lower average morning pain scores on postoperative day one; however, these findings were not considered statistically significant. To quantify postoperative opioid consumption, morphine equivalents were measured. The morphine equivalents consumed between the IPACK group and the control group were the same in the PACU; however, the IPACK group had less opioid consumption at 30 hours. These findings were not considered statistically significant.

In the discussion, Patterson et al. explained their findings in relation to their research question. The theoretical framework and review of the literature surrounding the importance of multimodal analgesia and regional anesthesia when managing TKA patients were reemphasized. Limitations to the study and potential improvements for future studies were also examined. Although statistical analysis varied, the result found that there were clinically significant statistics that support the supplementation of the IPACK block added to the ACB in TKA. In conclusion, Patterson et al. conducted a high-quality level 1 study utilizing randomized sampling and appropriate design methods that are directly applicable to anesthetic practice and TKA patient care.

**Tak et al., 2020**

Tak et al. designed this study to evaluate and compare the efficacy of the following 3 PNB techniques in TKA patients: single-shot ACB, continuous ACB with a catheter, and single-shot ACB and IPACK. This study was a double-blinded RCT, indicating that it was a level 1 design with strong evidence. The authors' inclusion criteria included patients between 45 and 80 years old with an ASA classification of I through III presenting for primary TKA. Exclusion criteria were vast and included patients with bilateral or revision TKA, knee flexion deformity greater than or equal to 30 degrees, varus-valgus deformity of greater than or equal to 30
degrees, rheumatoid arthritis, trauma, or septic arthritis, creatine greater than 1.2, renal or hepatic dysfunction, known allergy to any study medication, chronic opioid use, BMI greater than 40, chronic pain unrelated to knee joint, pre-existing neuropathy, arrhythmia, epilepsy, history of bleeding diathesis or primary vascular surgery on femoral vessels on operated site, and difficulty comprehending the VAS pain score system.

Tak et al. applied a power analysis of 0.8 and an alpha level of 0.05 to find that a sample size of 50 patients in each group would be appropriate. After 233 patients were screened and 53 were determined unqualified, 180 patients were considered eligible for the study. Utilizing computer-generated randomization, these patients were assigned to three groups: Group I, Group II, and Group III. Group I received single infiltration ACB, Group II received continuous ACB, and Group III received single infiltration ACB and IPACK block. All patients received PNBs from experienced providers under ultrasound guidance utilizing 0.2% ropivacaine. The same preoperative and postoperative medical regimen was also provided to all patients. The primary outcome measured was postoperative pain utilizing the VAS pain score. Secondary outcomes measured were opioid consumption measured by morphine equivalents. A p-value less than 0.05 was considered statistically significant.

Tak et al. illustrated their results in several well-organized tables. For this literature review, the results of Group I compared to Group III were analyzed. The authors found that when compared to Group I, Group III experienced less pain 8 hours postop, 16 hours postop, 32 hours postop, 40 hours postop, and after ambulation. Furthermore, Group III required less opioid consumption (32.110) compared to Group I (33.520). Although these findings were considered clinically significant, they were not considered statistically significant. The results of this study
suggest that the addition of the IPACK to ACB is superior to ACB alone in decreasing pain and opioid consumption in TKA.

**Vichainarong et al., 2020**

Vichainarong et al. implemented this study to analyze the efficacy of adding the IPACK block to local infiltration with continuous ACB in TKA patients. After the review of previous literature, the authors hypothesized that the addition of the IPACK would decrease opioid requirements and pain scores when compared to the ACB alone. This study was a double-blinded RCT, making it a level 1 study design.

The authors included a detailed description of their materials and methods. Inclusion criteria assessed ASA I through III patients scheduled for elective primary TKA. Exclusion criteria included patients less than 18 or greater than 80 years old, BMI greater than 40, inability to provide informed consent, a cognitive or psychiatric history that may interfere with assessment, a varus-valgus knee deformity greater than 20 degrees, knee flexion deformity greater than 30 degrees, contraindication for spinal anesthesia or peripheral nerve block, allergy or intolerance to local anesthetic drugs or any component of the multimodal analgesic regimen, pre-existing chronic pain or opioid drug use, and pre-existing neuropathy or neurologic deficit in the lower extremities.

With a 0.8 power analysis and a 2-sided alpha of 0.05, Vichainarong et al. determined that a sample size of 31 patients per group was needed. After 113 patients were assessed and 41 were not deemed eligible, 65 patients participated in the study. Computer-generated randomization divided the sample size into 2 groups. The 32 patients in the control group received a sham IPACK block, local infiltration, and a continuous ACB and the 33 patients in the intervention group received the IPACK block, local infiltration, and a continuous ACB. All PNB
were administered under ultrasound guidance and all patients received the same preoperative treatment. The primary outcomes measured were cumulative intravenous postoperative morphine consumption at 12 hours, 24 hours, and 48 hours. Secondary outcomes measured were pain scores at various time intervals utilizing the numerical rating scale (NRS) where 0 is no pain and 10 is the worst pain. A p-value less than 0.05 was considered statistically significant.

Vichainarong et al. found that the patients in the IPACK group required less morphine consumption at 12 hours (0.1 ± 0.5mg), 24 hours (0.6 ± 1.3mg), and 48 hours (0.7 ± 1.4mg) compared to the control group at 12 hours (0.4 ± 1mg), 24 hours (1.3 ± 1.9mg) and 48 hours (1.4 ± 1.9mg), respectively. Although clinically significant, these findings were not considered to be statistically significant. Utilizing the NRS, secondary outcome results indicated that patients in the IPACK group experienced less pain at rest at 4 hours, 12 hours, 24 hours, 36 hours, and 48 hours postoperatively than the control group. These findings were also considered to be statistically insignificant. When compared to the control group, the IPACK group experienced less pain with movement at 4 hours, 8 hours, 12 hours, 24 hours, 36 hours, and 48 hours postoperatively. These findings were all considered to be statistically significant.

In the discussion, Vichainarong et al. noted that a major limitation of this study was limiting the amount of local anesthetic dose to decrease the chance of the development of local anesthetic systemic toxicity (LAST). The authors further discussed that the addition of the IPACK block to ACB has benefits in TKA pain management. Although statistical significance was not produced in opioid consumption, the effectiveness of the IPACK block to the ACB in TKA was demonstrated. Further studies are needed to replicate similar results.

Ochroch et al., 2020
Ochroch et al. published a study entitled “Analgesic Efficacy of Adding the IPACK Block to a Multimodal Analgesia Protocol for Primary Total Knee Arthroplasty” to evaluate the effectiveness of adding the IPACK block on analgesic outcomes in TKA patients. The authors hypothesized that the addition of the IPACK block would improve posterior knee pain and overall analgesia in primary TKA patients. This study was a prospective RCT indicating that it was a high-quality level 1 design.

The methods of this study design were thoroughly summarized, and inclusion and exclusion criteria were clearly defined. Patients aged 18 through 80 years old with an ASA classification of I through III presenting for primary TKA were considered eligible participants. Exclusion criteria included allergy to any of the study medications, BMI greater than 45, coagulopathy, chronic kidney disease, recent chronic opioid therapy, and patients undergoing revision knee replacements. Utilizing a power analysis of 0.9 and an alpha of 0.05, the researchers decided that a sample size of 46 patients per intervention was needed.

Ochroch et al. screened 464 patients for eligibility. After inclusion and exclusion criteria were applied, 119 patients were included in the study. Following computer-generated randomization, 60 patients were assigned to the IPACK group, where they received an IPACK block in addition to a continuous ACB, and 59 patients were assigned to the control group, where they received a continuous ACB and a sham IPACK block. All PNBs were performed under ultrasound guidance utilizing the same dose of local anesthetic and all patients received the same standardized care. The primary outcome measured was the presence of posterior knee pain. Secondary outcomes measured were pain scores at 6-hour intervals utilizing the NRS and opioid consumption measured in morphine equivalents. A $p$-value less than 0.05 was considered clinically significant.
Ochroch et al. discovered that the results of their study supported their hypothesis.\textsuperscript{12} These findings were illustrated in several well-organized and detailed tables. Ochroch et al. found that the patients in the IPACK group experienced a reduction in posterior knee pain 0 hours, 6 hours, 12 hours, 18 hours, 24 hours, 42 hours, and 48 hours postoperatively when compared to the control group. Statistical significance occurred at the 6-hour mark with a \( p \)-value less than 0.01. Furthermore, when compared to the control group, the addition of the IPACK block resulted in a decrease in overall mean pain scores 6 hours, 12 hours, 18 hours, 24 hours, 36 hours, and 48 hours postoperatively. The 6-, 12-, and 48-hour pain score difference was considered clinically significant. Interestingly, the reduction of reported pain did not result in a decrease in opioid consumption in the IPACK group. Opioid consumption among both the IPACK and the control group was the same throughout all time intervals after TKA.

In the discussion, Ochroch et al. noted that the novel IPACK block is a promising analgesic adjunct for TKA patients.\textsuperscript{12} The authors found that the addition of the IPACK block to the ACB was beneficial in decreasing both posterior knee pain and overall mean pain following TKA, compared to the ACB alone. They further discussed that no reduction in opioid consumption may have been a result of the way opioids are prescribed and administered at their institution. The limitations to the study included a lack of adjuncts used, such as dexamethasone, to prolong the duration of PNB, in addition to the inherently subjective assessment that occurs with pain reporting. Given the relative ease and safety profile of the IPACK block, Ochroch et al. believe that there is a potential benefit of its use in TKA; however, more studies are needed.\textsuperscript{12}
<table>
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<th>Authors</th>
<th>Purpose</th>
<th>Methodology/Research Design</th>
<th>Interventions</th>
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| Li et al., 2020  | To evaluate the efficacy of ACB combined with additional analgesic methods for postoperative analgesia in patients with primary TKA | Level 1: Single-center, prospective, double-blinded RCT | **Group A:** ACB, LFCNB, IPACK  
**Group B:** ACB, IPACK  
**Group C:** ACB, LFCNB  
**Group D:** ACB | 310 patients were assessed for eligibility. After inclusion and exclusion criteria were applied, computer-generated randomization separated 200 patients into four groups. | Group B had lower postoperative pain scores than Group D, both at rest and with activity 2 hours, 8 hours, 12 hours, 24 hours, and 48 hours, and at discharge.  
Statistical significance occurred 8 hours at rest, 12 hours at rest, 2 hours with activity, and 8 hours with activity postoperatively (p-value < 0.05). | This study showed statistically significant and clinical benefits of the addition of the IPACK to the ACB in TKA. |
|                  |                                                                         |                             | All PNBs were performed under ultrasound guidance by a senior anesthetist with 0.2% ropivacaine and 2mcg/mL of epinephrine, in addition to standardized care. | The sample size far exceeded the authors’ goals of 0.85 power and 0.05 level of significance, which originally equated to 50 patients in each group. | Group B had less opioid consumption than Group D in all postoperative time categories including at 0 to 24 hours, 24 to 48 hours, 48 hours to discharge, and total consumption.  
Statistical significance occurred at 24 hours and with total consumption. |                                                                                       |
| Patterson et al., 2020<sup>10</sup> | To evaluate the effect of the addition of the IPACK block to the ACB on pain, walking distance, and hospital stay in patients undergoing unilateral TKA | Level 1: Single-center, prospective, double-blinded, RCT | IPACK Group: Continuous ACB, IPACK Control Group: Continuous ACB, 2mL subcutaneous normal saline injection. All PNB were performed under ultrasound guidance with 0.25% ropivacaine with 3mcg/mL epinephrine, in addition to standardized care. | 72 patients were assessed for eligibility. After exclusion and criteria, 69 patients were assigned to two groups utilizing a randomization generating tool. The sample size exceeded the authors’ goals of 0.8 power and 0.05 level of significance, which totaled 64 patients. IPACK group had statistically significant lower pain scores at rest in PACU than the control group (p-value < 0.05). IPACK group had less pain during physical therapy in the PACU and lower average morning pain scores on postoperative day one, however, these findings were not considered statistically significant. Opioid consumption between the IPACK group and the control group was the same in the PACU. IPACK | (p-value < 0.05). Group B had a statistically significant longer analgesic duration of 17.9 hours, compared to the 13.09 duration that occurred in Group D (p-value < 0.05). Clinical findings support the supplementation of the IPACK block added to the ACB in TKA, however, statistical analysis varied. |
To evaluate and compare the efficacy of three PNB techniques in primary TKA patients: single-shot ACB, continuous ACB with a catheter, and single-shot ACB + IPACK.
unrelated to knee joint, pre-existing neuropathy, arrhythmia, epilepsy, history of bleeding diathesis or primary vascular surgery on femoral vessels on operated site, and difficulty comprehending the VAS pain score system

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<th>Vichainarong et al., 2020(^{11})</th>
<th>To analyze the efficacy of adding the IPACK block to local infiltration with continuous ACB in primary TKA patients</th>
<th>Level 1: Double-blinded RCT</th>
<th>IPACK Group: IPACK, local infiltration, continuous ACB.</th>
<th>After 113 patients were assessed and 41 were not deemed eligible, 65 patients participated in the study. Computer-generated randomization divided the sample size into two groups.</th>
<th>IPACK group experienced less pain at rest 4 hours, 12 hours, 24 hours, 36 hours, and 48 hours postoperatively than the control group. These findings were considered to be statistically insignificant.</th>
<th>Results indicated that the addition of the IPACK block to ACB has benefits in TKA pain management. Although statistical significance was not produced in opioid consumption, the effectiveness of the IPACK was demonstrated.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>Inclusion Criteria: ASA I-III patients scheduled for elective primary TKA</td>
<td>Control Group: Sham IPACK, local infiltration, continuous ACB</td>
<td>This sample size exceeded the authors’ 0.8 power analysis and a two-sided alpha of 0.05, which determined that a sample size of 31</td>
<td>IPACK group experienced less pain with movement 4 hours, 8 hours, 12 hours, 24 hours, 36 hours, and 48 hours postoperatively. These</td>
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<td>Exclusion Criteria: Patients &lt; 18 or &gt; 80 years old, BMI &gt; 40, inability to provide informed consent, a cognitive or psychiatric history that may interfere with assessment, a varus-valgus knee deformity &gt; 20</td>
<td>All patients received PNBs from experienced providers under ultrasound guidance utilizing 0.25% levobupivacaine with 5mcg/mL</td>
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</table>
degrees, knee flexion deformity > 30 degrees, contraindication for spinal anesthesia or peripheral nerve block, allergy or intolerance to local anesthetic drugs or any component of the multimodal analgesic regimen, pre-existing chronic pain or opioid drug use, pre-existing neuropathy or neurologic deficit in the lower extremities

epinephrine, in addition to standardized care.

patients per group was needed.

findings were considered to be statistically significant ($p$-value < 0.05)

IPACK group required less opioid consumption at 12 hours (0.1 ± 0.5mg), 24 hours (0.6 ± 1.3mg), and 48 hours (0.7 ± 1.4mg) compared to the control group at 12 hours (0.4 ± 1mg), 24 hours (1.3 ± 1.9mg) and 48 hours (1.4 ± 1.9mg). These findings were not considered to be statistically significant.

<table>
<thead>
<tr>
<th>Ochroch et al., 2020$^{12}$</th>
<th>To evaluate the effectiveness of adding the IPACK block on analgesic outcomes in primary TKA patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1: Prospective RCT</td>
<td>Inclusion Criteria: Patients aged 18-80 years old with an ASA classification of I-III presenting for primary TKA</td>
</tr>
<tr>
<td>Control Group: ACB, sham IPACK with subcutaneous infiltration of LA. All patients received PNBs from experienced providers under 464 patients were screened for eligibility. After inclusion and exclusion criteria were applied, 119 patients were included in the study. Computer-generated randomization divided the sample size into two groups. IPACK group experienced a reduction in posterior knee pain 0 hours, 6 hours, 12 hours, 18 hours, 24 hours, 42 hours, and 48 hours postoperatively when compared to the control group. Statistical significance occurred at the 6-hour mark ($P$-value &lt; 0.01). The addition of the IPACK block to the ACB was beneficial in decreasing both posterior knee pain and overall mean pain following TKA, compared to the ACB alone. The IPACK block</td>
<td></td>
</tr>
<tr>
<td>Allergy to any of the study medications, BMI &gt; 45, coagulopathy, chronic kidney disease, recent chronic opioid therapy, and patients undergoing revision knee replacements</td>
<td>ultrasound guidance utilizing 0.5% ropivacaine, in addition to standardized care.</td>
</tr>
</tbody>
</table>
Summary of the Evidence

The five studies included in this literature review were all peer-reviewed, RCTs published within 5 years. The methodology and study design of these articles indicate that they are the highest level of evidence. Although each author measured slightly different outcomes, they all evaluated the efficacy of adding the novel IPACK block to the ACB in primary TKA patients. The effect of the IPACK block on pain scores and opioid consumption in each RCT was extracted.

Li et al., Patterson et al., Tak et al., Vichainarong et al., and Ochroch et al. all found that the addition of the IPACK block to the ACB reduced postoperative pain scores in TKA patients, compared to the ACB alone.\(^7,9-12\) Statistical significance was established at various time intervals in each study, either at rest or with activity. Furthermore, results from Li et al., Tak et al., Patterson et al., and Vichainarong et al. showed that the IPACK block decreased opioid consumption; however, only Li et al. found statistical significance.\(^7,9-11\) Interestingly, Ochroch et al. found that opioid consumption among both the IPACK and the control group was the same throughout all time intervals measured.\(^12\)

Definition of Terms

Total Knee Arthroplasty (TKA)

Total knee arthroplasty (TKA), also known as a total knee replacement, is the surgical treatment for end-stage knee osteoarthritis.\(^10\) It is the most effective intervention; however, it is associated with significant postoperative pain.

Interspace Between the Popliteal Artery and the Capsule of the Knee (IPACK) Block

The IPACK block is a motor-sparing peripheral nerve block that is performed under ultrasound guidance to anesthetize branches of the sciatic nerve to provide analgesia to the
posterior knee.\textsuperscript{9}

**Adductor Canal Block (ACB)**

The adductor canal block (ACB) is an ultrasound-guided peripheral nerve block that involves the injection of local anesthesia into the fascial compartment of the sartorius muscle from the apex of the femoral triangle to the adductor hiatus.\textsuperscript{11} It is known to cover the anteromedial aspect of the knee joint.

**Local Anesthesia**

Local anesthetics are a class of medications that attach to the inside of the voltage-gated sodium channel to inhibit neuronal ion transfer and prevent depolarization and further neuronal transmission. At normal doses, this mechanism augments sensation and can result in decreased sensory and motor function.

**Primary DNP Project Goal**

A goal statement is important because it provides a framework for strategic planning. The goal statement should be thorough and follow the acronym SMART: specific, measurable, achievable, realistic, and timely. The goal of this project is to increase anesthesia provider knowledge on how the IPACK block, when combined with the ACB, can improve postoperative pain and decrease opioid consumption in TKA patients, compared to the ACB alone.

**Specific**

Anesthesia providers will understand how the IPACK block, when combined with the ACB, can improve postoperative pain and decrease opioid consumption in TKA patients compared to the ACB alone.

**Measurable**

To understand the effectiveness of the IPACK block in TKA, participants will be
provided a learning module. The participants will answer a questionnaire before and after receiving the learning module. Outcomes will be measured by evaluating the pre- and post-module knowledge of the TKA patient population, TKA prevalence, TKA anesthesia techniques, the goal of the IPACK block, the benefits of the IPACK block, and what nerves the IPACK block target. Qualtrics will be utilized to create and analyze the questionnaire.

**Achievable**

All anesthesia providers will be given the opportunity to participate in the questionnaire and the learning module via email. This includes MD anesthesiologists, certified registered nurse anesthetists (CRNAs), and student registered nurse anesthetists (SRNAs).

**Realistic**

Participating anesthesia providers will be educated on the TKA patient population, TKA prevalence, current TKA anesthesia techniques, the goal of the IPACK block, the benefits of the IPACK block, and what nerves the IPACK block target.

**Timely**

The educational module will be completed and available to anesthesia providers within a three-month time frame. The outcome of this project is the following: within 3 months, anesthesia providers will understand the TKA patient population, TKA prevalence, TKA anesthesia techniques, the goal of the IPACK block, the benefits of the IPACK block, and what nerves the IPACK block target.

**Program Structure**

The development of the IPACK block educational module was completed through a multidisciplinary effort with the collaboration of regional anesthesia specialists. A thorough assessment was performed to identify the strengths, weaknesses, opportunities, and threats
(SWOT) of the educational module. A SWOT analysis identifies internal and external attributes of the module’s effectiveness.  

The first step to developing the IPACK block educational module is to acknowledge key stakeholders. Key stakeholders for this project include anesthesia providers and orthopedic surgeons. These stakeholders were given a questionnaire to assess their knowledge regarding the TKA patient population, TKA prevalence, TKA anesthesia techniques, the goal of the IPACK block, the benefits of the IPACK block, and what nerves the IPACK block target. Participants were then provided with a comprehensive educational module. The module was delivered electronically via email. After the intervention, the stakeholders completed the same questionnaire. Effectiveness was analyzed by the variation of results before and after the educational module.

**Strengths**

The IPACK block is a simple, effective, and promising PNB used to reduce postoperative pain and improve surgical outcomes for TKA. The IPACK block aims to anesthetize branches of both the sciatic nerve and the obturator nerve to provide analgesia to the posterior knee. It is an appealing approach because it blocks the sensory branches of the sciatic nerve while sparing motor function. Motor-sparing sensory blockade is ideal because it facilitates early ambulation, functional recovery, and hospital discharge. Due to its motor-sparing effects, studies have demonstrated that when added to the ACB, the IPACK block is associated with reduced postoperative pain and reduced opioid consumption in TKA. This educational module will highlight its effectiveness and increase providers’ awareness of the IPACK block.

**Weakness**

Although local anesthetics are generally considered safe, there are risks associated with
their use, including the development of local anesthetic systemic toxicity (LAST). LAST is a rare but life-threatening event that can lead to neurological inhibition and cardiovascular collapse. The development of LAST is most commonly a consequence of inadvertent intravascular injection but has also been associated with the systemic accumulation of large volumes of LAs through the use of PNBs, fascial plane blocks, and neuraxial anesthesia.

There is no single best intervention proven to eliminate the risk of developing LAST. The best know defense is prevention. When administering LAs, it is recommended that the lowest dose necessary be administered and ultrasound guidance be utilized. Thorough instructions on how to properly perform the IPACK block with LA will be provided in the educational module.

Opportunities

Chronic joint disease requiring total joint replacement is a common condition in the United States. With a prevalence rate of around 1.52%, the number of individuals that have had TKA is nearly 5 million people. Furthermore, data indicates that over 1 million TKA procedures are performed each year in the United States. As human life expectancy continues to rise, the annual prevalence of TKA volume is also predicted to increase. By 2030, the rate of TKA is expected to increase to over 3 million surgeries per year. Studies have projected that without a rise in incidence rates, the aging population alone will result in 7.4 million people living with TKA by 2030.

The average length of a TKA hospital stay is 3.7 days and associated costs remain high. Kremers et al. found that the average hospital stay for TKA costs $15,673 with the largest proportion of costs being room and board. Furthermore, patients that experience a hospital complication, such as uncontrolled pain, will incur a 34% increase in costs due to prolonged length of hospital stay. As the prevalence rates of TKA rise, the economic burden increases as
well. Adequate pain management will help decrease the length of hospital stay, reduce healthcare costs, and improve satisfaction for TKA patients.

**Threats**

The main threat to incorporating the IPACK block into the anesthetic plan for TKA is the attitudes and perceptions of orthopedic surgeons. Although the use of regional anesthesia is becoming more popular, many orthopedic surgeons are still reluctant about its use. Despite its known advantages, many surgeons perceive that PNBs have unpredictable success and often causes surgical delays. Without the approval of the surgeon, the use of this regional technique will be frowned upon. To combat this threat, anesthesia providers often establish a team dedicated to administering regional anesthesia in a designated block room. A designated block room will maintain throughput, scheduling, and increase efficiency. The educational module highlighted the importance of maintaining perioperative throughput to improve the attitudes and perceptions of orthopedic surgeons.

**Organizational Factors**

The implementation of this educational module was conducted in collaboration with the perioperative team. All members of the team were presented with a voiceover PowerPoint presentation in addition to the pre- and post-module assessments. There was a goal of 100% team participation. After the assessments were analyzed, the data were compared to assess module effectiveness. A summary of the findings was discussed among the collaborative team. A final report detailing the description of the program, interventions, findings, limitations, and further research needs were then authored.

**Theoretical Framework**

In an attempt for providers to better understand pain, there have been many pain theories
developed throughout history. According to Peterson and Bredow, pain, in theory, is an unpleasant sensory and affective experience associated with tissue injury following surgery or trauma.\textsuperscript{14} It is a top priority for anesthesia providers to utilize pain theory to understand and properly treat pain in TKA patients. Furthermore, the middle-range theory “A Balance Between Analgesia and Side Effects” states the best way to achieve effective pain control and also limit side effects is through the following: the multimodal method, attentive nursing care, and active patient participation.\textsuperscript{14} The multimodal method includes potent pain medication and pharmacological and nonpharmacological adjuvants. Potent pain medications such as opioid analgesics are known to provide quick relief, however, carry many unpleasant side effects including nausea, vomiting, drowsiness, urinary retention, and respiratory depression.\textsuperscript{14} Because of this, a combination of nonpharmacological adjuvants and pharmacological adjuncts is recommended. Nonpharmacological adjuvants include temperature (hot/cold) therapy, relaxation techniques, music therapy, and manual massage. Recommended non-opioid pharmacological adjuvants that reduce pain include PNBs, such as the IPACK block, acetaminophen, ketamine, NSAIDs, and COX-2 inhibitors.

**Methodology**

**Setting and Participants**

This study took place at Mount Sinai Medical Center (MSMC), a large, private, not-for-profit teaching hospital located in Miami Beach, Florida. MSMC is a 672-bed hospital that employs around 4,000 people and performs over 10,000 surgeries per year. It is the largest independent teaching hospital in South Florida and the only hospital located in Miami Beach. Surgical service lines include but are not limited to: surgical oncology, cardiothoracic surgery, general surgery, neurosurgery, urological surgery, ENT surgery, and orthopedic surgery. In
addition to paid employees, MSMC educates 162 residents, 477 medical students, 230 nursing students, 66 physician assistant students, and 153 allied health students, all from various culturally diverse backgrounds.

**Description of Approach and Project Procedures**

The DNP project intervention began by inviting all anesthesia providers at MSCM to participate in this study. A pretest and posttest study design was used to measure the providers' knowledge of TKA anesthesia techniques and the IPACK block. Data were collected regarding the providers’ age, education, certifications, and years of practice. The pretest, training module, and posttest were then implemented. The educational module had an expected duration of 20 minutes. After completion, participants were asked to take a survey to assess their personal opinions regarding the efficacy of the educational module.

**Protection of Human Subjects**

All anesthesia providers from MSMC were invited to participate in this project through email. Once the Institutional Review Board (IRB) determines that this study does not pose more than minimal risk, all participants consented to HIPAA compliance utilizing Qualtrics. At any time throughout the study, participants had the right to withdraw consent. Benefits of participation include possible knowledge improvement of TKA and TKA anesthesia techniques including the IPACK block. Some participants may not be open to change or have the time to participate in the study. Identifiable data were not collected throughout this study; however, depending on the sample size, participants may be identifiable indirectly. A password-protected online database only accessible by the primary researcher was utilized to store the data of this study.
Data Collection

The collected demographic data included age, gender, race, ethnicity, education, licensure, certifications, and years of practice. The pretest and posttest included a curated multiple-choice survey. The assessment included questions specific to TKA, nerve innervations of the knee joint, and TKA anesthesia techniques. Individual pretest results were compared to the posttest results to determine study efficacy.

Data Management and Analysis Plan

A password-protected online electronic database stored all data for this project. The primary researcher was the only person to have access to the database. All results were reported in aggregate and no direct identifiers were utilized. Questionnaires were stored electronically, and a mean score was extrapolated and compared before and after the intervention.

Results

Pretest Demographics

After consenting to participate, 8 anesthesia providers completed the demographics questionnaire, the pretest assessment, the educational module, and the posttest assessment. The majority of participants identified as female \( n = 5, 62.5\% \) opposed to male \( n = 3, 37.5\% \). The ages of the participants ranged from 20-30 \( n = 1, 12.5\% \), 31-40 \( n = 4, 37.5\% \), 41-50 \( n = 2, 25\% \), and 51-60 \( n = 2, 25\% \). Ethnicities varied and included Hispanic or Latino \( n = 4, 50\% \), White or Caucasian \( n = 3, 37.5\% \), Black or African American \( n = 1, 12.5\% \), and Asian \( n = 1, 12.5\% \). The participants were highly educated having completed a Master’s degree \( n = 1, 12.5\% \), doctoral degree \( n = 5, 62.5\% \), and post-doctoral degree \( n = 2, 25\% \). The majority of participants were Certified Registered Nurse Anesthetists (CRNAs) \( n = 7, 87.5\% \); however, one physician anesthesiologist also participated \( n = 1, 12.5\% \).
participants had a wide range of work experience including 1-5 years ($n = 3, 37.5\%$), 6-10 years ($n = 2, 25\%$), 11-20 years ($n = 2, 25\%$), and greater than 21 years ($n = 1, 12.5\%$).

Table 1. Pretest Participant Demographics

<table>
<thead>
<tr>
<th>Demographic</th>
<th>n (%)</th>
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<tbody>
<tr>
<td>Total Participants</td>
<td>8 (100%)</td>
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<tr>
<td><strong>Gender</strong></td>
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<tr>
<td>Male</td>
<td>3 (37.5%)</td>
</tr>
<tr>
<td>Female</td>
<td>5 (62.5%)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
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<tr>
<td>20-30 years old</td>
<td>1 (12.5%)</td>
</tr>
<tr>
<td>31-40 years old</td>
<td>3 (37.5%)</td>
</tr>
<tr>
<td>41-50 years old</td>
<td>2 (25%)</td>
</tr>
<tr>
<td>51-60 years old</td>
<td>2 (25%)</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
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<tr>
<td>White</td>
<td>3 (37.5%)</td>
</tr>
<tr>
<td>Black or African American</td>
<td>1 (12.5%)</td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>4 (50%)</td>
</tr>
<tr>
<td>Asian</td>
<td>1 (12.5%)</td>
</tr>
<tr>
<td><strong>Highest Level of Education</strong></td>
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<tr>
<td>Master Degree</td>
<td>1 (12.5%)</td>
</tr>
<tr>
<td>Doctoral Degree</td>
<td>5 (62.5%)</td>
</tr>
<tr>
<td>Post-Doctoral Degree</td>
<td>2 (25%)</td>
</tr>
<tr>
<td><strong>Position/Title</strong></td>
<td></td>
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<tr>
<td>CRNA</td>
<td>7 (87.5%)</td>
</tr>
<tr>
<td>MD</td>
<td>1 (12.5%)</td>
</tr>
<tr>
<td><strong>Years of Experience</strong></td>
<td></td>
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<tr>
<td>1-5 years</td>
<td>3 (37.5%)</td>
</tr>
<tr>
<td>6-10 years</td>
<td>2 (25%)</td>
</tr>
<tr>
<td>11-20 years</td>
<td>2 (25%)</td>
</tr>
<tr>
<td>Greater than 21 years</td>
<td>1 (12.5%)</td>
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</table>

Pretest Total Knee Arthroplasty Knowledge

Prior to completing the educational module, half of the participants ($n = 4, 50\%$) knew that TKA was the most common surgical procedure. The other half of the participants believed that the most common surgical procedure was either appendectomy ($n = 2, 25\%$) or cholecystectomy ($n = 2, 25\%$). When asked what about postoperative pain, half of the participants ($n = 4, 50\%$) believed 40\% of TKA patients experienced severe postoperative pain, 3
participants (37.5%) believed 60% of TKA patients experienced severe postoperative pain, and 1 participant (12.5%) believed 20% of TKA patients experienced severe postoperative pain. Furthermore, prior to completing the educational module, half the participants \((n = 4, 50\%)\) knew that the average age of a TKA patient was 68, 3 participants (37.5%) believed that the average age of a TKA patient was 58, and 1 participant (12.5%) believed that the average age of a TKA patient was 48. Due to the age of this surgical population, TKA patients are at a higher risk for anesthesia complications. Prior to this learning module, the majority of participants \((n = 7, 87.5\%)\) knew that TKA patients are more prone to postoperative delirium due to a loss of circulating neurotransmitters, whereas one participant (12.5%) believed that they are more prone to peripheral nerve injury.

**Pretest Knowledge on Total Knee Arthroplasty Regional Techniques**

When asked to recall TKA nerve anatomy, all participants \((n = 8, 100\%)\) knew that the femoral nerve innervates the anteromedial aspect of the knee. Moreover, all participants \((n = 8, 100\%)\) knew that the sciatic nerve innervates the posterior aspect of the knee. Prior to the educational module, 3 participants (37.5%) knew that the appropriate peripheral nerve blocks for TKA included the adductor canal block (ACB), the IPACK block, and the sciatic nerve block (SNB). Two participants (25%) only selected 2 answers and failed to include the IPACK block, 2 participants (25%) incorrectly chose the quadratus lumborum (QL) block instead of the SNB, and 1 participant (12.5%) incorrectly chose the QL block instead of the IPACK block. When asked to describe the IPACK block, only 1 participant (12.5%) knew that the IPACK block aims to block branches of the sciatic nerve and was associated with motor-sparing sensory blockade. Half the participants \((n = 4, 50\%)\) incorrectly believed that the IPACK block was associated with motor-sparing sensory blockade of the femoral nerve. One participant (12.5%) believed the
IPACK block blocked branches of the femoral nerve, and 2 participants (25%) believed that it blocked branches of both the femoral and the sciatic nerve. Prior to the educational module, the majority of participants (n=7, 87.5%) knew that when added to the ACB, the IPACK block decreased postoperative pain and decreased opioid consumption in TKA patients. One participant (12.5%), however, believed that when added to the ACB, the IPACK block decreased postoperative pain and increased opioid consumption in TKA patients. When asked how to perform the IPACK block, more than half of the participants (n = 5, 62.5%) knew that under ultrasound guidance, 20mL of local anesthetic is deposited in the tissue plane between the popliteal artery and the capsule of the knee. Two participants (25%) believed that 15mL of local anesthetic is deposited between the adductor magnus muscle and the biceps femoris muscle, adjacent to the sciatic nerve, and one participant (12.5%) believed that 10mL of local anesthetic is deposited anterior to the femoral artery, deep to the sartorius muscle.

Pretest Knowledge and Utilization of IPACK Block

The educational module assessed knowledge and utilization of the IPACK block. Prior to this educational module, half of the participants (n = 4, 50%) were not familiar with the IPACK block. Furthermore, 2 participants (25%) were slightly familiar and two participants (25%) were moderately familiar with the regional technique. Prior to this learning module, three participants (37.5%) were extremely unlikely to use the IPACK block to reduce postoperative pain and opioid consumption in TKA patients and 3 participants (37.5%) were somewhat unlikely to utilize the IPACK block. Moreover, 1 participant (12.5%) was somewhat likely to utilize the IPACK block, and 1 participant (12.5%) was extremely likely to utilize the regional technique.
**Posttest Total Knee Arthroplasty Knowledge**

After completing the educational module, anesthesia providers’ knowledge of total knee arthroplasty improved. The majority of the participants ($n = 7, 87.5\%$) were able to recall that TKA was the most common surgical procedure performed in the United States. When asked about postoperative pain, 6 of the participants (75\%) were able to recall that 60\% of TKA patients experienced severe postoperative pain. Moreover, after completing the educational module, 6 of the participants (75\%) knew that the average age of a TKA patient was 68 years old. Due to the age of this surgical population, TKA patients are at a higher risk for anesthesia complications. The majority of participants ($n = 7, 87.5\%$) knew that TKA patients are more prone to postoperative delirium due to a loss of circulating neurotransmitters before and after the educational module. Table 2 shows the difference in pre to posttest TKA knowledge. There was an improvement in 3 out of 4 questions illustrating that the educational module was effective at improving anesthesia provider TKA knowledge.

**Table 2. Difference in Pre- and Posttest (Total Knee Arthroplasty Knowledge)**

<table>
<thead>
<tr>
<th>Question</th>
<th>Correct in Pretest</th>
<th>Correct in Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the most common surgical procedure performed in the United States?</td>
<td>50.0%</td>
<td>87.5%</td>
</tr>
<tr>
<td>What percentage of TKA patients experience severe postoperative pain?</td>
<td>37.5%</td>
<td>75.0%</td>
</tr>
<tr>
<td>What is the average age of a TKA patient?</td>
<td>50.0%</td>
<td>75.0%</td>
</tr>
<tr>
<td>Loss of brain weight/volume coupled with a decline in circulating neurotransmitters make this patient population more sensitive to anesthetics and more prone to which anesthesia complication?</td>
<td>87.5%</td>
<td>87.5%</td>
</tr>
</tbody>
</table>
Posttest Knowledge on Total Knee Arthroplasty Regional Techniques

When asked to recall TKA nerve anatomy, all participants \((n = 8, 100\%)\) knew that the femoral nerve innervates the anteromedial aspect of the knee and that the sciatic nerve innervates the posterior aspect of the knee prior to the educational module. Following the educational module, however, 6 participants \((75\%)\) correctly chose that the femoral nerve innervates the anteromedial aspect of the knee and 7 participants \((87.5\%)\) correctly recalled that the sciatic nerve innervates the posterior aspect of the knee. After the educational module, 5 participants \((62.5\%)\) knew that the appropriate peripheral nerve blocks for TKA included the adductor canal block (ACB), the IPACK block, and the sciatic nerve block (SNB). When asked to describe the IPACK block, 2 participants \((25\%)\) were able to recall that the IPACK block aims to block branches of the sciatic nerve and was associated with motor-sparing sensory blockade. After the educational module, 7 participants \((87.5\%)\) knew that when added to the ACB, the IPACK block decreased postoperative pain and decreased opioid consumption in TKA patients. After the learning module, 7 participants \((87.5\%)\) were able to correctly recall how to perform the IPACK block. After completion of the educational module, there was an improvement in 3 out of 6 questions regarding TKA regional techniques. There was a decline in two questions regarding nerve anatomy and 1 question had the same outcome pre- and post-educational module. Table 3 illustrates the differences in results from the pre- to posttest.

Table 3. Difference in Pre- and Posttest (Knowledge on TKA Regional Techniques)

<table>
<thead>
<tr>
<th>Question</th>
<th>Correct in Pretest</th>
<th>Correct in Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which nerve innervates the anteromedial aspect of the knee?</td>
<td>100.0%</td>
<td>75.0%</td>
</tr>
<tr>
<td>Which nerve innervates the posterior aspect of the knee?</td>
<td>100.0%</td>
<td>87.5%</td>
</tr>
</tbody>
</table>
Which of the following are regional techniques appropriate for TKA? Select 3.

37.5%  62.5%

Which of the following statements best describe the IPACK block? Select 2.

12.5%  25.0%

When added to the adductor canal block (ACB), the IPACK block has been shown to have what effect on TKA patients?

87.5%  87.5%

Which of the following statements best describe how to perform the IPACK block?

62.5%  87.5%

Posttest Knowledge and Utilization of IPACK Block

The educational module assessed knowledge and utilization of the IPACK block.

Following the educational module, half of the participants \( (n = 4, 50\%) \) were not familiar with the IPACK block. Furthermore, 2 participants \( (25\%) \) were slightly familiar, and 2 participants \( (25\%) \) were moderately familiar with the regional technique. These results were the same as the pretest. Following the learning module, half of the participants \( (n = 4, 50\%) \) were extremely likely to use the IPACK block to reduce postoperative pain and opioid consumption in TKA patients. This was an improvement from the pretest. Table 4 illustrates the differences in response regarding the knowledge and utilization of the IPACK block.

Table 4. Difference in Pre- and Posttest (Knowledge and Utilization of the IPACK Block)

<table>
<thead>
<tr>
<th>Question</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior to this learning module, how familiar were you with the IPACK block?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not familiar at all</td>
<td>50.0%</td>
<td>50.0%</td>
</tr>
<tr>
<td>Slightly familiar</td>
<td>25.0%</td>
<td>25.0%</td>
</tr>
<tr>
<td>Moderately familiar</td>
<td>25.0%</td>
<td>25.0%</td>
</tr>
<tr>
<td>Very familiar</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Extremely familiar</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>How likely are you to use the IPACK block to reduce postoperative pain and opioid consumption in TKA patients?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Extremely unlikely       37.5%  12.5%
Somewhat unlikely       37.5%  25.0%
Neither likely or unlikely 0.0%  12.5%
Somewhat likely         12.5%  0.0%
Extremely likely        12.5%  50.0%

Summary

Overall, the results showed that the educational module was effective at increasing provider knowledge regarding the IPACK’s block efficacy in TKA. As illustrated in Table 5, 6 participants (75%) improved their overall assessment scores after completing the educational module, one participant (12.5%) had the same pretest and posttest scores, and 1 (12.5%) participant scored worse on the posttest assessment. Furthermore, prior to this learning module, half of the participants \((n = 4, 50\%)\) had no familiarity with the IPACK block. After receiving the educational intervention, participants gained familiarity with the IPACK block and half \((n = 4, 50\%)\) stated that they would be extremely likely to utilize the IPACK block to reduce postoperative pain and opioid consumption in TKA patients.

Table 5. Difference in Pre- and Posttest (Overall Results Based on Individual Provider)

<table>
<thead>
<tr>
<th>Participant</th>
<th>Total Questions Correct in Pretest</th>
<th>Total Questions Correct in Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant #1</td>
<td>30.0%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Participant #2</td>
<td>90.0%</td>
<td>90.0%</td>
</tr>
<tr>
<td>Participant #3</td>
<td>60.0%</td>
<td>90.0%</td>
</tr>
<tr>
<td>Participant #4</td>
<td>60.0%</td>
<td>80.0%</td>
</tr>
<tr>
<td>Participant #5</td>
<td>70.0%</td>
<td>80.0%</td>
</tr>
<tr>
<td>Participant #6</td>
<td>60.0%</td>
<td>70.0%</td>
</tr>
</tbody>
</table>
Discussion

Limitations

There were limitations to this project. First, there was a small sample size. Out of the 35 anesthesia providers from Mount Sinai Medical Center that were invited to participate, only 8 participants completed the educational module. After 2 weeks of initial invitation, reminder emails were sent to every provider encouraging participation, yet the response rate did not improve. Moreover, the project was conducted over a relatively short period of time. A project conducted over a longer period of time with a larger sample size would have yielded stronger results. Additionally, this project was asynchronous and delivered entirely online. In person delivery may have yielded more participation.

Future Implications to Advanced Nursing Practice

There is a vast amount of evidence that correlates poor outcomes in patients with uncontrolled pain and increased opioid consumption. The IPACK block is a quick and efficient intervention that could ultimately decrease the length of hospital stay and in turn, decrease hospital costs. This project gave anesthesia providers familiarity with the IPACK block and the confidence to consider implementing this novel regional anesthesia technique into the standard of care for TKA patients. Overall, there was an increased number of correct responses in the posttest compared to the pretest, illustrating that knowledge was gained and that educational modules are an effective learning tool to increase provider knowledge. In the future, a larger
sample size with an in-person emphasis on how to perform the ultrasound-guided IPACK block would be beneficial for both TKA patients and anesthesia providers.
References


Appendix A: IRB Exemtional Approval

MEMORANDUM

To: Dr. Valerie Diaz
CC: Alyssa See

From: Maria Melendez-Vargas, MIBA, IRB Coordinator

Date: March 18, 2022

Protocol Title: “An Educational Module Explaining the Utilization of the IPACK Block Technique to Decrease Postoperative Pain and Opioid Consumption in Total Knee Arthroplasty Patients: A Quality Improvement Project”

The Florida International University Office of Research Integrity has reviewed your research study for the use of human subjects and deemed it Exempt via the Exempt Review process.

IRB Protocol Exemption #: IRB-22-0084
IRB Exemption Date: 03/18/22
TOPAZ Reference #: 111465

As a requirement of IRB Exemption you are required to:

1) Submit an IRB Exempt Amendment Form for all proposed additions or changes in the procedures involving human subjects. All additions and changes must be reviewed and approved prior to implementation.

2) Promptly submit an IRB Exempt Event Report Form for every serious or unusual or unanticipated adverse event, problems with the rights or welfare of the human subjects, and/or deviations from the approved protocol.

3) Submit an IRB Exempt Project Completion Report Form when the study is finished or discontinued.

Special Conditions: N/A

For further information, you may visit the IRB website at http://research.fiu.edu/irb.

MMV/em
Appendix B: Letter of Support

Miami Beach Anesthesiology Associates, Inc.
Mount Sinai Medical Center • Division of Anesthesia

February 1, 2022

Dr. Valerie Diaz, DNP, CRNA, APRN
Assistant Professor
Department of Nurse Anesthesiology
Florida International University

Dr. Diaz,

Thank you for inviting Mount Sinai Medical Center to participate in Doctor of Nursing Practice (DNP) project conducted by Alyssa See entitled "An Educational Module Explaining the Utilization of the IPACK Block Technique to Decrease Postoperative Pain and Opioid Consumption in Total Knee Arthroplasty Patients: A Quality Improvement Project" in the Nicole Wertheim College of Nursing and Health Sciences, Department of Nurse Anesthesiology at Florida International University. I have given the student permission to conduct the project using our providers.

Evidence-based practice's primary aim is to yield the best outcomes for patients by selecting interventions supported by the evidence. This proposed quality improvement project seeks to investigate and synthesize the latest evidence.

We understand that participation in the study is voluntary and carries no overt risk. All Division of Anesthesia providers are free to participate or withdraw from the study at any time. The educational intervention will be conveyed by a 15-minute virtual PowerPoint presentation, with a pretest and posttest questionnaire delivered by a URL link electronically via Qualtrics, an online survey product. Responses to pretest and posttest surveys are not linked to any participant. The collected information is reported as an aggregate, and there is no monetary compensation for participation. All collected material will be kept confidential, stored in a password encrypted digital cloud, and only be accessible to the investigators of this study: Alyssa See and Dr. Diaz.

Once the Institutional Review Board's approval is achieved, this scholarly project's execution will occur over two weeks. Alyssa See will behave professionally, follow standards of care, and not impede hospital performance. We support the participation of our Division of Anesthesia providers in this project and look forward to working with you.

Respectfully,

Jampierre (J.P.) Malo, DNP, CRNA, APRN
Executive CRNA Director
SRNA Coordinator/Supervisor
Electronic Mail: Jampierre@bellsouth.net
Mobile Phone: 954-668-6080

4300 Alton Road, Suite 2454, Miami Beach, FL 33140
Office (305) 674-2742 • Facsimile (305) 674-9723
Appendix C: Letter of Consent

CONSENT TO PARTICIPATE IN A QUALITY IMPROVEMENT PROJECT
“An Educational Module Explaining the Utilization of the IPACK Block Technique to Decrease Postoperative Pain and Opioid Consumption in Total Knee Arthroplasty Patients: A Quality Improvement Project”

SUMMARY INFORMATION
Things you should know about this study:

- **Purpose**: Educational module concerning utilization of the IPACK block to decrease pain and opioid consumption in total knee arthroplasty (TKA) patients.
- **Procedures**: If you choose to participate, you will be asked to complete a pretest, watch a voice PowerPoint, and complete a post-test.
- **Duration**: This will take about a total of 20-minutes.
- **Risks**: The main risk or discomfort from this research is minimal.
- **Benefits**: The main benefit from this project is to increase the participants’ knowledge of the IPACK block in TKA patients.
- **Alternatives**: There are no known alternatives available to you other than not taking part in this study.
- **Participation**: Taking part in this research project is voluntary.

Please carefully read the entire document before agreeing to participate.

PURPOSE OF THE PROJECT
The goal of this project is to educate anesthesia providers on how the IPACK block, when combined with the adductor canal block (ACB), can decrease postoperative pain and opioid consumption in total knee arthroplasty (TKA) patients compared to the ACB alone. You are being asked to participate in this quality improvement project.

NUMBER OF STUDY PARTICIPANTS
If you decide to participate, you will be one of approximately 10 people in this study.

DURATION OF THE PROJECT
Your participation will require about 20 minutes of your time.

PROCEDURES
If you agree to be in the project, we will ask you to do the following things:

RISKS AND/OR DISCOMFORTS
There are no foreseeable risks with you for participating in this project.

BENEFITS
The following benefits with your participation in this project: An increase in your knowledge regarding the TKA patient population, the nerve innervation of the knee, current TKA regional techniques, the benefits of the IPACK block, how to perform the IPACK block, and your perception and attitude toward utilization of the IPACK block.

ALTERNATIVES
There are no known alternatives available to you other than not taking part in this project. However, if you would like to receive the educational material given to the participants in this project, it will be provided to you at no cost.

CONFIDENTIALITY
The records of this project will be kept private and will be protected to the fullest extent provided by law. If, in any sort of report we might publish, we will not include any information that will make it possible to identify you as a participant. Records will be stored securely, and only the project team will have access to the records.

PARTICIPATION
Taking part in this research project is voluntary.

COMPENSATION & COSTS
There is no cost or payment to you for receiving the health education and/or for participating in this project.

RIGHT TO DECLINE OR WITHDRAW
Your participation in this project is voluntary. You are free to participate in the project or withdraw your consent at any time during the project. Your withdrawal or lack of participation will not affect any benefits to which you are otherwise entitled. The investigator reserves the right to remove you without your consent at such time that they feel it is in the best interest.

RESEARCHER CONTACT INFORMATION
If you have any questions about the purpose, procedures, or any other issues relating to this research project, you may contact Alyssa See at 419-565-2261 or asee004@fiu.edu or Dr. Valerie Diaz at 305-348-9027 or vdiaz@fiu.edu.

IRB CONTACT INFORMATION
If you would like to talk with someone about your rights pertaining to being a subject in this project or about ethical issues with this project, you may contact the Florida International University Office of Research Integrity by phone at 305-348-2494 or by email at ori@fiu.edu.

PARTICIPANT AGREEMENT
I have read the information in this consent form and agree to participate in this study. I have had a chance to ask any questions I have about this study, and they have been answered for me. By clicking on the “consent to participate” button below I am providing my informed consent.
Appendix D: Pretest and Posttest Questionnaire

Pretest and Posttest Questionnaire:

An Educational Module Explaining the Utilization of the IPACK Block Technique to Decrease Postoperative Pain and Opioid Consumption in Total Knee Arthroplasty Patients: A Quality Improvement Project

INTRODUCTION:

The goal of this DNP project is to educate anesthesia providers on how the IPACK block, when combined with the adductor canal block (ACB), can decrease postoperative pain and opioid consumption in total knee arthroplasty (TKA) patients compared to the ACB alone.

Please answer the question below to the best of your ability. The questions include demographic information and knowledge of the utilization of the IPACK block. Questions are in multiple choice style format and are meant to measure the anesthesia provider’s knowledge of the effectiveness of the IPACK block to decrease postoperative pain and opioid consumption in total knee arthroplasty.

PERSONAL INFORMATION:

1. What is your age?
   a. 20-30 years old
   b. 31-40 years old
   c. 41-50 years old
   d. 51-60 years old
   e. Greater than 60 years old

2. What is your gender?
   a. Male
   b. Female
   c. Non-binary/third gender
   d. Prefer not to say

3. What is your ethnicity?
   a. White
   b. Black or African American
   c. Hispanic or Latino
   d. American Indian or Alaska Native
   e. Asian
f. Native Hawaiian or Pacific Islander
g. Other

4. What is your level of education?
   a. Bachelor degree
   b. Master degree
   c. Doctoral degree
   d. Post-Doctoral degree

5. What is your position/title?
   a. CRNA
   b. MD
   c. Other

6. How many years of experience do you have?
   a. Less than 1 year
   b. 1 to 5 years
   c. 6 to 10 years
   d. 11 to 20 years
   e. Greater than 21 years

QUESTIONNAIRE:

1. What is the most common surgical procedure performed in the United States?
   a. Total knee arthroplasty (TKA)
   b. Appendectomy
   c. Laminectomy
   d. Cholecystectomy

2. What percentage of TKA patients experience severe postoperative pain?
   a. 10%
   b. 20%
   c. 40%
   d. 60%

3. What is the average age of a TKA patient?
   a. 48
   b. 58
   c. 68
   d. 78

4. Loss of brain weight/volume coupled with a decline in circulating neurotransmitters make this patient population more sensitive to anesthetics and more prone to which anesthesia complication?
   a. Postoperative Delirium
   b. Postoperative Nausea/Vomiting (PONV)
c. Awareness Under Anesthesia
d. Peripheral Nerve Injury

5. Which of the following are regional techniques appropriate for TKA? Select 3.
   a. Adductor Canal Block (ACB)
   b. Transversus Abdominis Plane (TAP) Block
c. Interspace Between the Popliteal Artery and Capsule of the Knee (IPACK) Block
d. Interscalene Block
e. Sciatic Nerve Block (SNB)
f. Quadratus Lumborum (QL) Block

6. Which nerve innervates the anteromedial aspect of the knee?
   a. Femoral
   b. Sciatic
c. Common peroneal
d. Tibial

7. Which nerve innervates the posterior aspect of the knee?
   a. Femoral
   b. Sciatic
c. Sural
d. Saphenous

8. Which of the following statements best describe the IPACK block? Select 2.
   a. Aims to block branches of the sciatic nerve
   b. Aims to block branches of the femoral nerve
c. Associated with motor-sparing sensory blockade
d. Associated with profound motor blockade

9. When added to the adductor canal block (ACB), the IPACK block has been shown to have what effect on TKA patients?
   a. Decreased postoperative pain and decreased opioid consumption
   b. Decreased postoperative pain and increased opioid consumption
c. No change in postoperative pain and opioid consumption
d. Increased postoperative pain and increased opioid consumption

10. Which of the following statements best describe how to perform the IPACK block?
    a. Under ultrasound guidance, 10mL of local anesthetic is deposited anterior to the femoral artery, deep to the sartorius muscle
    b. Under ultrasound guidance, 15mL of local anesthetic is deposited between the adductor magnus muscle and the biceps femoris muscle, adjacent to the sciatic nerve
c. Under ultrasound guidance, 15mL of local anesthetic is deposited to the lateral aspect of the femoral nerve, below the fascia iliaca
d. Under ultrasound guidance, 20mL of local anesthetic is deposited in the tissue plane between the popliteal artery and the capsule of the knee
11. Prior to this learning module, how familiar were you with the IPACK block?
   a. Not familiar
   b. Slightly familiar
   c. Moderately familiar
   d. Very familiar
   e. Extremely familiar

12. How likely are you to use the IPACK block to reduce postoperative pain and opioid consumption in TKA patients?
   a. Extremely unlikely
   b. Somewhat unlikely
   c. Neither likely or unlikely
   d. Somewhat likely
   e. Extremely likely