

OPIOID REDUCTION AFTER ORTHOPAEDIC SURGERY

THE PERCEPTIONS OF ORTHOPAEDIC SURGEONS AND PATIENTS ON OPIOID
REDUCTION AFTER TOTAL JOINT REPLACEMENT

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A Thesis Submitted to the School of Graduate Studies in Partial Fulfilment of the
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TITLE: The Perceptions of Orthopaedic Surgeons and Patients on Opioid Reduction After Total Joint Replacement

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LAY ABSTRACT

Opioid analgesics are routinely prescribed to manage pain after total knee and hip replacement surgery. However, opioids are not typically more effective than alternatives and are associated with addiction, overdose, and death. This thesis aims to understand the perceptions of patients and orthopaedic surgeons on opioid use after total knee and hip replacement surgery. The findings demonstrate that more patients are open to receiving opioid-reduced surgery compared to opioid-free surgery, with receptivity being associated with patients' perceptions of opioid efficacy and safety and current opioid use, highlighting a need for improved patient education. Additionally, orthopaedic surgeons identified challenges and facilitators to postoperative opioid reduction in six key areas: opioid prescribing practices, patient factors, collaborative care, policies/guidelines, surgeon education and training, and personal perceptions/beliefs. Compared to Canadian and Dutch surgeons, Japanese surgeons heavily relied on non-opioid medications as they believed that opioids are unnecessary for managing postoperative pain.

ABSTRACT

With an increasing prevalence of osteoarthritis, total knee (TKA) and hip (THA) arthroplasty are the second-and third-most common surgeries in Canada. Although these procedures improve pain and function for a majority of patients, some patients report persistent postoperative pain. Opioids are conventionally used for these patients even though they are associated with addiction, falls, overdose, and death. Recently, many strategies have been proposed to decrease reliance on opioids after TKA and THA, including opioid-free and opioid-reduced multimodal protocols for pain management. Our findings demonstrate that Canadian patients' receptivity to opioid-free or reduced postoperative protocols is associated with their perception of the efficacy and safety of opioids compared to non-opioid alternatives, and current opioid use. More patients are open to opioid-reduced postoperative care as they perceive that pain will be intolerable without opioids. This overlaps with many Canadian surgeons' perception that opioids cannot be completely eliminated from postoperative pain management regimens and that patients expect an intolerable level of pain after surgery, warranting opioid use. This highlights a need for enhanced patient education on the safety and efficacy of opioids and alternatives, while managing patients' expectations of postoperative pain control. Most Canadian and Dutch surgeons reported that they prescribe opioids to nearly all of their patients postoperatively. However, our cross-sectional study indicates that 40% of Canadian patients would be open to receiving no opioids postoperatively. In contrast, Japanese surgeons believed that opioids are unnecessary for managing postoperative pain. Variations observed among orthopaedic surgeons in Canada, the Netherlands, and Japan can be attributed to differences at the surgeon-level (individual practices and beliefs), patient-level (patient characteristics and preferences), and system-level (regulatory frameworks and healthcare systems). Further research is required on surgeon-centered approaches to mitigating opioid use, focusing on education and guidelines/policies for opioid prescribing.

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LIST OF ABBREVIATIONS AND SYMBOLS

OA	Osteoarthritis
TJA	Total Joint Arthroplasty
TKA	Total Knee Arthroplasty
THA	Total Hip Arthroplasty
NSAIDs	Non-Steroidal Anti-Inflammatory Drugs
COX-2	Cyclooxygenase-2
AAHKS	American Association of Hip and Knee Surgeons
MOJO	Minimizing Opioids After Joint Operation
ED	Emergency Department
VAS	Visual Analogue Scale
REDCap	Research Electronic Data Capture
SD	Standard Deviation
IQR	Interquartile Range
VIF	Variance Inflation Factor
OR	Odds Ratio
CI	Confidence Interval
PM	Pain Medications
Ref	Reference
OP	Opioid Prescribing
QD	Qualitative Description
CA	Canada
NL	The Netherlands
JAP	Japan
LOS	Length of Stay
PRN	Pro re nata
SUD	Substance Use Disorder
WHO	World Health Organization
HCP	Health Care Providers

DECLARATION OF ACADEMIC ACHIEVEMENT

I, Mansi Patel, declare my thesis to be my own research work. I am the sole author of this thesis document and was involved in all stages of the research projects, under the supervision of Dr. Jason W. Busse. Dr. Sheila Sprague, Dr. Kim Madden, and Dr. Jason W. Busse provided methodological support, and contributed to the editing and refinement of the thesis. To my knowledge, the content of this document does not infringe on any copyrights.

Chapter 1: Addressing the opioid epidemic in orthopaedic surgery

INTRODUCTION

Osteoarthritis and total joint arthroplasty

Osteoarthritis (OA) is a progressive condition characterized by chronic pain and functional disability and has a complex pathophysiology. Knee and hip OA is estimated to be the 12th highest contributor to global disability and are the most common reasons for total joint arthroplasty (TJA)^{1, 2}. In 2020, the global prevalence of knee OA was 16% in individuals aged 15+, and over 87 million people (aged 20+) had incident knee OA³. Likewise, from 1990 to 2019, there was a 115% increase in the worldwide incidence of hip OA, rising from 0.74 million to 1.58 million cases⁴. The rise in the incidence of OA is driven by the increasing elderly population, obesity, and sports-related injuries, all of which are risk factors for the condition⁵. The first line of treatment for individuals with OA is often a combination of non-pharmacological strategies (e.g., physiotherapy, weight management, education) and pharmacological modalities, such as non-steroidal anti-inflammatory drugs (NSAIDs), acetaminophen, topical therapies, intra-articular injections, and at times, opioid analgesics. However, total knee (TKA) and hip arthroplasty (THA) are commonly performed for end-stage disease refractory to non-surgical treatments⁵.

Although OA is one of the most common indications for TKA and THA, it may also be performed for rheumatoid arthritis, trauma, hereditary disorders, or developmental problems. TKA and THA involve reconstructing the worn joint surfaces of the knee and hip joints with prosthetic components⁶. In Canada, TKA and THA are the second and third-most performed surgeries, respectively, with a 17% rise in TKA and a 19% increase in THA over the past five years⁷. Although TKA and THA may lead to favorable outcomes

for many, some patients may experience chronic postsurgical pain, defined as pain that persists for at least three months. Chronic postoperative pain may result in lower patient satisfaction and, ultimately greater societal and health care expenses due to a potential for revision surgery and long-term recovery⁸.

Postoperative pain

Approximately one-third of THA and one-half of TKA patients experience moderate to severe acute pain after their surgery, which may result from tissue injury or damage^{9, 10}. Preoperative pain and use of opioid analgesics, greater pain catastrophizing, depression, and increased anxiety may be risk factors for developing acute postsurgical pain. A systematic review and meta-analysis of 30 observational studies assessing the predictors of persistent post-surgical pain following TKA reported high certainty evidence for increased risk with moderate-to-severe acute post-operative pain¹⁰. It may be plausible that sensitization (increased responsiveness to less/non-painful stimuli), changes in nociceptors, and altered neuroplasticity may result in chronic pain stemming from acute pain⁹. NSAIDs, acetaminophen, or opioids can be used to manage postoperative pain. Specifically, NSAIDs reduce inflammation while concomitantly inducing an anti-nociceptive effect, acetaminophen reduces pain sensation by crossing the blood–brain barrier and increasing serotonin in several areas of the brain, while opioids have mechanisms of action at several levels of the nervous system⁹. Historically, opioids have been extensively utilized to manage postoperative pain, notwithstanding their potential for adverse effects. In light of the escalating number of individuals necessitating TJA, opioid use has emerged as an alarming issue for orthopedics.

The opioid crisis

The opioid crisis is a burgeoning and multifaceted public health issue characterized by increased misuse and abuse of prescription and non-prescription opioids and, subsequently fatalities and hospitalization. The opioid crisis emerges from the complex interplay between several individual (e.g., pain, socio-demographics, etc.), interpersonal (e.g., opioid access, family history, etc.), community (e.g., norms, over-prescription, geography, etc.), and societal (e.g., opioid supply, media, policies/laws, etc.) factors¹¹. As opioids may result in nausea, lethargy, respiratory depression, sedation, urinary retention, drug-induced hypotension, addiction, overdose, falls, and even death, there has been a paradigm shift in favour of multimodal pain management strategies to reduce opioid use¹². Notably, North America has the greatest per-person consumption of prescription opioids globally. In Canada, there were 34,455 deaths from opioid toxicity between 2016 and 2022¹³. As orthopaedic surgeons are the third-highest opioid prescribers in the USA and are responsible for approximately 60% of opioid prescriptions to opioid-naïve patients, there has been considerable interest in mitigating opioid use after orthopaedic surgery¹⁴.

Opioid reduction in orthopaedic surgery

Over the last several years, the epidemic has gained the attention of scholars, researchers, healthcare professionals, and politicians¹¹. Consequently, a myriad of strategies and regulations have been proposed and implemented to abate the issue. In orthopaedics, there has been considerable interest in finding non-opioid alternatives and developing opioid-sparing multimodal protocols for postoperative pain management to mitigate opioid use. Multimodal pain regimens involve multiple classes of medications and techniques, with

differing mechanisms of action, to improve pain control and diminish opioid prescribing and, in turn, decrease postoperative morbidity and mortality¹². For instance, multimodal analgesia regimens that reduce or avoid the use of opioids may incorporate pharmacological approaches such as peripheral nerve blocks, cyclooxygenase-2 (COX-2) inhibitors, gabapentinoids, local anesthetic infiltration, acetaminophen, and NSAIDs. Additionally, non-pharmacological adjuncts such as acupuncture, electrotherapy, and transcutaneous electrical nerve stimulation may also be utilized¹⁵.

Aside from physiologically managing pain, multimodal models also consist of preoperative and postoperative educational efforts to manage patients' expectations of pain control while informing them of potential benefits and adverse effects of their pain medications. Preoperative education may be the most important facet of such programs as it may condition patients into expecting that their pain will be managed, which may reduce anxiety and an exaggerated pain response¹². Several studies have reported that implementing opioid-sparing multimodal approaches for TKA and THA patients decreases postoperative opioid consumption¹⁶⁻¹⁸. Nonetheless, a recent scoping review of 141 studies, comparing opioid-reduction interventions after orthopedic surgery to a control group, found that multimodal analgesia was used in less than 25% of studies within each procedure type, highlighting that this approach is underused or applied inconsistently¹⁵. This review also reported that despite education being a critical component of multimodal approaches, an educational intervention was used in only four studies (2.8%). Accordingly, further research is necessitated to assess the use of multimodal regimens, including patient-centered and provider-centered education, for managing postoperative pain. At the

institutional and systemic levels, implementing opioid prescribing guidelines, and continuing education and training for orthopaedic surgeons may aid in optimizing prescribing practises¹⁵.

Overview of the thesis

it is essential to consider the viewpoints of patients and surgeons to optimize the effectiveness of multimodal opioid-sparing or opioid-free postoperative protocols. Personal experiences, individual preferences, and cultural factors may play a role in determining the success of these programs. Hence, this thesis seeks to explore the perceptions of patients (**Chapter 2**) and surgeons (**Chapter 3**) concerning opioid use and prescribing, respectively, following TKA and THA. By understanding the perspectives of both groups, potential gaps in knowledge, misconceptions, or issues that may compound opioid reduction programs can be identified. Additionally, comparing surgeon perceptions across three countries with varying levels of opioid use and prescribing (Canada, Japan, and the Netherlands) may aid in identifying similarities, differences, and potential best practices that can be shared among countries. Thereupon, targeted interventions and programs can be developed to enhance patient outcomes, reduce opioid dependence, and promote safer pain management practices. This thesis concludes with a brief discussion of the findings and conclusions (**Chapter 4**).

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**Chapter 2: Patient perceptions towards reduction or avoidance of opioids following
knee and hip replacement surgery: A cross-sectional survey**

ABSTRACT

Introduction: Approximately 25% of patients report chronic pain after TKA and 11% after THA. Opioid analgesics are routinely prescribed to manage post-surgical pain but may not be more effective than alternatives and are associated with important harms.

Methods: We administered a cross-sectional survey to patients scheduled to undergo, or had undergone, TKA or THA. The survey collected demographic information, perceptions of opioid efficacy and safety, and asked patients if they would be open to receiving: 1) opioid reduction after TKA/THA and 2) opioid elimination after TKA/THA. We constructed multivariable logistic regression models to explore features associated with patients' receptivity to opioid reduction and avoidance.

Results: We acquired 190 completed surveys. 25% of respondents believed that other analgesics worked similarly or better than opioids, and 68% perceived that opioids were associated with more side effects than alternatives. 50% advised they would be willing to accept reduced opioid use after TKA/THA. Endorsement was associated with the belief that opioids had more side effects than alternatives (OR 3.4, 95%CI 1.5 to 7.9) and not using opioids at the time of survey completion (OR 2.5, 95%CI 1.0 to 6.4). 40% reported they would be willing to avoid the use of opioids, and endorsement was associated with the belief that opioids cause more side effects than alternatives (OR 4.3, 95%CI 1.8 to 11.9) and that non-opioid analgesics are similarly or more effective (OR 3.4, 95%CI 1.4 to 8.3).

Conclusions: Among a sample of patients, most of whom had undergone TKA, half would be willing to accept opioid reduction after surgery, and 40% would be willing to avoid

opioids altogether. These findings suggest opportunities, focusing on patient education, to reduce use of opioids after TKA/THA.

Keywords: Opioid medication; opioid dependence; knee arthroplasty; hip arthroplasty; patient perceptions; patient education; pain management

INTRODUCTION

Knee and hip osteoarthritis and total joint arthroplasty

Osteoarthritis is characterized by chronic pain, stiffness, and joint deformity. It can be attributed to a complex interplay between systemic (e.g., age, ethnicity, nutrition, etc.) and local biomechanical factors (e.g., obesity, joint deformity, injury, etc.)¹. In 2020, the global prevalence of knee OA was 16% in individuals aged 15+, and over 87 million people (aged 20+) had incident knee OA². From 1990 to 2019, there was a 115% increase in the worldwide incidence of hip OA, rising from 0.74 million to 1.58 million cases³. In 2016, approximately 6 million Canadians aged 15+ were diagnosed with arthritis, and this figure is expected to exceed 9 million by 2040⁴. The rising incidence of OA is partly fuelled by an aging population and increased prevalence of obesity, both of which are risk factors for the condition¹.

The experience of pain is a crucial symptom of OA that prompts individuals to seek medical care and is associated with disability¹. Although numerous interventions exist for managing OA, TKA and THA are the most common procedures used to treat end-stage disease unresponsive to conservative care. In Canada, TKA and THA are the second and third-most performed surgeries, respectively, due to the rising prevalence of OA. From 2019 to 2020, more than 75,000 knee replacements and 63,000 hip replacements were performed. There has been a 17% rise in TKA and a 19% increase in THA in Canada over the past five years⁵. Consequently, OA is a pressing public health issue that imposes a significant economic burden on both individuals and society, which is projected to rise.

Pain following TKA and THA

Despite a favourable outcome for many, roughly 29% of THA and 51% of TKA patients experience moderate to severe acute pain after surgery⁶. Moreover, 25% of patients report chronic pain after TKA, and 11% after THA^{7, 8}. Opioid analgesics have traditionally been used for the management of postoperative pain despite their potential for adverse effects. Given the high prevalence of acute and chronic postoperative pain, opioid use is common after arthroplasty⁹.

The opioid crisis

The liberal use of opioid analgesics in the treatment of pain, and the insufficient regulation and profit-driven motives of the pharmaceutical and health-care industries have contributed to the burgeoning opioid crisis in North America^{10, 11}. The opioid crisis refers to the increase in the incidence of deaths and hospitalizations resulting from the rising use of prescription and non-prescription opioids¹². Extended use or high doses may result in physical dependence, addiction, overdose, and even death¹³. In Canada, there were 34,455 deaths from opioid toxicity between 2016 and 2022¹⁴. A systematic review of 38 studies found that the rate of misuse averaged between 21% and 29% among individuals consuming opioids for chronic pain relief¹⁵. Data from the 2018 Canadian Community Health Survey exhibits that 10% of Canadians aged 15+ reported non-medical use of prescription opioid medications¹⁶. Accordingly, there has been increasing interest in opportunities to reduce opioid prescribing.

Opioid reduction and elimination after TJA

Orthopaedic surgeons are the third-highest opioid prescribers in the USA and are responsible for approximately 60% of opioid prescriptions to opioid-naïve patients¹⁷. A prospective study of 110 patients undergoing primary TJA at an academic center in the USA reported that THA patients consumed significantly fewer opioids than TKA patients. However, both groups received more opioids than were used (a single prescription for oxycodone 5 mg totaling 84 tablets)¹⁸.

Ongoing research suggests that opioid-free or opioid-reduced postoperative care may represent a promising opportunity to help mitigate the opioid crisis. To effectively implement programs aimed at reducing opioid use, it is essential to recognize the complexities associated with pain stemming from characteristics of different patient populations and understand the need to provide alternative forms of pain relief that are not solely reliant on opioids. Opioid-reduced/free multimodal analgesia regimens may include pharmacologic modalities (e.g., peripheral nerve blocks, cyclooxygenase-2 inhibitors, gabapentinoids, local anesthetic infiltration, acetaminophen, NSAIDs) and nonpharmacologic modalities that are considered as adjuncts (e.g., acupuncture, electrotherapy, transcutaneous electrical nerve stimulation)¹⁹. However, programs designed to reduce opioid use should not only address the physiological management of pain but also incorporate educational efforts on opioid use, and identify patients at high risk for adverse effects.

A prospective cohort study with 386 TKA patients receiving a multimodal protocol combining patient-specific preoperative education, continuous adductor canal block with

ropivacaine, and self-directed postoperative rehabilitation, found that 86% of patients required ten or fewer opioid pills through 12 weeks postoperatively²⁰. However, a survey exploring the current analgesia and anesthesia practices used by TJA surgeons of the American Association of Hip and Knee Surgeons (AAHKS) found that an average of 49 opioid pills (range 0-200) are prescribed for TKA, which may result in unused medications²¹. Likewise, a retrospective chart review of 20 patients that had TKA using the “Minimizing Opioids after Joint Operation (MOJO)” postoperative pain protocol found decreased opioid use after TKA without compromising pain control or increasing emergency department (ED) visits²². Another retrospective study, implementing an opioid-sparing pain management protocol for THA, found a significant reduction in inpatient and discharge opioid consumption in the intervention versus control group²³.

Although there are many complete and ongoing studies assessing the efficacy of opioid-reduced/free protocols after TKA and THA, no studies assess patient perceptions regarding opioid use after surgery. Exploring patient perceptions of opioid use can aid in identifying potential barriers, misconceptions, or fears that may affect patients' receptivity and adherence to opioid-sparing protocols or alternative pain management strategies. This information can guide the development of interventions to address these concerns, thereby optimizing patient outcomes.

OBJECTIVES

The primary objective of this study is to determine the proportion of patients who would be open to receiving reduced or no opioids after TKA and THA. The secondary objectives

are to identify patient characteristics that are associated with receptivity to opioid-free or reduced postoperative care, determine patients' perceptions regarding the efficacy and safety of opioids, and understand potential barriers to the implementation of an opioid-free or reduced program.

METHODS

Study design

This is a cross-sectional study consisting of a questionnaire to determine patients' perceptions of opioid efficacy and safety, and receptivity to opioid reduction and opioid avoidance after TKA and THA.

Questionnaire development

Orthopaedic surgeons, epidemiologists, and pain management experts informed the development of our questionnaire. Previous literature regarding quantitative questionnaires has shown that closed-ended questions result in fewer incomplete questions than open-ended formats²⁴. Thus, almost all questions were answered with either a nominal or Likert scale. Open-ended questions were used sparingly and were intended to capture patient thoughts that may be missed by closed-ended questioning alone. The survey was developed to capture data on respondent demographic characteristics, pain, surgical factors, openness to receiving post-surgical care without or with reduced opioids, perceptions regarding the efficacy and safety of opioids, and potential barriers to the implementation of an opioid-free or opioid-reduced postoperative care program (**Appendix 2-A**). We employed the Visual Analogue Scale (VAS), measuring pain intensity on a scale of 0-100mm, to capture

patients' pain level. Participants who had scheduled/planned surgery provided anticipated levels of postoperative pain, while those in the postoperative phase recalled their pain levels during the initial days after surgery. Additionally, all patients indicated their current pain level on the day of completing the survey. We qualified pain as mild (scores of ≤ 30), moderate (31 to 70), or severe (>70)²⁵. We measured patients' satisfaction with in-hospital and discharge medications using a 100-point scale (0 = least satisfied, 100 = most satisfied)²⁶.

Settings and participants

Participants were adult patients scheduled for, or following up after, primary TKA and THA, who provided informed consent at two orthopaedic clinics (St. Joseph's Healthcare Hamilton and Juravinski Hospital, Hamilton, Ontario, Canada). Patients eligible to participate in our study were:

1. Over the age of 18
2. Presenting for a preoperative appointment OR a postoperative, up to 12 months post-surgery, appointment
3. Able to read, write, and understand English
4. Were not judged to be cognitively impaired and were able to respond to the questionnaire

Questionnaire administration

We collected data for this investigation via a digital online survey hosted on Research Electronic Data Capture (REDCap) (<https://www.project-redcap.org/>) from February 2019

to February 2023 (recruitment was halted from the end of 2019 to the end of 2021 during the COVID-19 pandemic). A research assistant identified eligible patients in the two participating clinics. Eligible patients provided informed consent on a digital form on REDCap and completed the questionnaire on tablet computers (with an option to complete a paper version). The research assistant was present to aid and answer questions and, when required, transferred information from the paper-based survey to REDCap. All procedures were approved by the Hamilton Integrated Research Ethics Board (Project number 5669; McMaster University).

Statistical analysis

We entered surveys into a secure study-specific database, REDCap, and generated frequencies for all collected data. We reported categorical data as proportions, and continuous data as means and standard deviations (SD) if normally distributed, and as medians and interquartile range (IQR) if not. The Shapiro-Wilk test was used to test for normality for continuous variables. We reported the overall prevalence of patients who would be open to receiving postoperative care without or with reduced opioids as the percentage of patients who responded “Definitely Yes” or “Probably Yes” to the corresponding questions.

We performed two multivariable logistic regression analyses to evaluate factors associated with patients’ openness to receiving 1) opioid-free postoperative care and 2) opioid-reduced postoperative care. We collapsed responses to create a binary dependant factor (“Definitely Yes” and “Probably Yes” vs. “Not Sure”, “Definitely No” and “Probably No”). As data should contain at least ten events in the minority class for each

factor entered into a multivariable logistic regression model, we combined some categories for the education, and perceptions of adverse effects and efficacy of opioids variables to minimize the risk of overfitting the regression model²⁷⁻²⁹. Guided by previous literature, we selected seven independent variables, *a priori*, that may be associated with receptivity to opioid-reduced and opioid-free postoperative care and predicted the direction of anticipated effects. We hypothesized that patients would be more receptive to opioid reduction or avoidance after their surgery if they 1) have acquired post-secondary education^{18, 30}, 2) perceive opioids as having more side-effects than alternatives³¹, 3) perceive other medications to be more or equally effective as opioids³¹, 4) do not have chronic pain in any other joints^{32, 33}, 5) are not using opioids at the time of participation³⁴, 6) are scheduled/planned for surgery³⁵, and 7) have received or are scheduled for THA³⁶. We did not include gender and age in our adjusted models as they are not reported by previous literature to be associated with participants' perceptions and knowledge of opioid use^{30, 31}. We excluded missing data from our multivariable regression analyses using listwise deletion. Multicollinearity was deemed concerning if the variance inflation factor (VIF) for any independent factor was greater than five³⁷. Additionally, we used the Hosmer-Lemeshow goodness-of-fit test to assess the overall fit of the model³⁸. We reported measures of association as odds ratios (OR) and associated 95% confidence intervals (CI). Statistical significance was defined as p-value < 0.05. We conducted all analyses using RStudio (v4.1.0; R Core Team 2021)³⁹, and we performed a summative content analysis to identify themes in responses to open-ended questions⁴⁰.

Sample size

The primary aim of this study was to determine the prevalence of patients open to receiving opioid-free and opioid-reduced care after TJA. Using the formula to calculate sample size for a prevalence study, $n = [Z^2 * P*(1-P)]/d^2$, a Z statistic of 1.96 (95% CI), a prevalence (P) of 0.5 (sample size requirement is most conservative), and a precision (d) of 5%, the required sample size was 384⁴¹. This requirement was inflated to 400 for convenience and to account for missing data.

RESULTS

Characteristics of respondents

Due to institutional restrictions in completing in-person research imposed by the COVID-19 pandemic, we halted recruitment at 200 participants. Among the 200 patients we approached, 190 completed our questionnaire. The median age of participants was 67 (IQR 60 – 73), and 65% were female (**Table 1**). For most respondents (36%), the highest level of education was college or trade school, followed by high school (24%). Twenty-two percent of participants reported an annual income between \$60,001 and \$80,000. A majority of respondents (87%) had received or were scheduled for TKA, and 78% already had their surgery and were presenting for a postoperative visit. 43% of participants indicated that they had knee/hip joint pain for six or more years before receiving or being scheduled for surgery, and 59% were experiencing chronic pain in joints other than the one being/was replaced at the time of survey completion. Additionally, 75% of individuals indicated they were presently using prescription or non-prescription medications for joint

pain, with 20% using opioid analgesics (**Table S2.1**). On the pain VAS scale, participants visiting postoperatively reported mild current knee/hip pain (20; IQR 2-50), while those with a planned/scheduled surgery indicated a moderate level of pain (60; IQR 49-80) (**Table 2** and **Table 3**)²⁵.

Respondents with surgery completed in the past year

Among participants who were attending a postoperative clinic, 72% (106 of 147) had unilateral TKA/THA, 46% (67 of 145) had received joint replacement 1-3 months prior to participation, and 27% (39 of 145) 6-12 months prior to participation (**Table 2**). Most respondents (65%; 96 of 147) reported that their joint pain was much better than before surgery, with only 3% (5 of 147) indicating worse pain. Participants recalled experiencing severe pain intensity (75; IQR 52-90) during the first several days after their surgery and indicated a satisfaction level of 90 (IQR 75-100) and 84 (IQR 58-99) with their in-hospital and discharge pain medications, respectively.

Respondents with surgery planned/scheduled

Forty-nine percent (20 of 41) of individuals were planned/scheduled for TJA 12+ months later, while 32% (13 of 41) had their surgery in less than one month (**Table 3**). The majority of participants (83%; 34 of 41) were having one joint replaced, and expected to have a severe intensity of pain (80; IQR 70-88) postoperatively.

Table 1 Baseline demographics of patients

Characteristic	N	Median (IQR); n (%)
Age	180	67 (60, 73)
Gender	189	
Male		66 (35)
Female		123 (65)
Education Level	188	
No high school		7 (4)
Some high school		18 (10)
High school completed		46 (24)
College/trade school		67 (36)
Bachelor's Degree		35 (19)
Graduate Degree		15 (8)
Income	171	
<=\$20,000		14 (8)
\$20,001-\$40,000		32 (19)
\$40,001-\$60,000		32 (19)
\$60,001-\$80,000		38 (22)
\$80,001-\$100,000		25 (15)
>\$100,001		30 (18)
Knee vs Hip Replacement	189	
TKA		164 (87)
THA		25 (13)
Level of Joint Pain Today	187	25 (6, 52)
Duration of Joint Pain (Years)	98	

0-1	12 (12)
2-3	26 (27)
4-5	18 (18)
6+	42 (43)
Other Joint Pain	188 110 (59)
Currently Using Pain Medications	189 141 (75)
Currently Using Opioids	190 38 (20)
Surgery Planned or Completed	190
TJA Planned/Scheduled	41 (22)
TJA Completed	149 (78)

TJA, Total Joint Arthroplasty

Table 2 Characteristics & perceptions of patients with surgery completed in the past year

Characteristic	N	Median (IQR) or n (%)
Age	142	66 (60, 73)
Gender	148	
Male		47 (32)
Female		101 (68)
Level of Joint Pain Today (VAS)	146	20 (2, 50)
Duration Since Surgery	145	
< 1 month		19 (13)
1-3 months		67 (46)
3-6 months		20 (14)
6-12 months		39 (27)
Number of Joints Replaced	147	
1 joint		106 (72)
2 joints at different times		29 (20)
2 joints simultaneously		12 (8.2)
Current Pain Vs. Pre-Op Pain	147	
Much better		96 (65)
A bit better		26 (18)
About the same		12 (8.2)
A bit worse		8 (5.4)
A lot worse		5 (3.4)
Pain Level First Few Days Post-Op	148	75 (52, 90)
Satisfaction with In-Hospital Medications	145	90 (75, 100)
Satisfaction with Discharge Medications	144	84 (58, 99)

VAS, Visual Analogue Scale

Table 3 Characteristics and perceptions of patients with surgery scheduled/planned

Characteristic	N	Median (IQR) or n (%)
Age	38	67 (58, 73)
Gender	41	
Male		19 (46)
Female		22 (54)
Level of Joint Pain Today (VAS)	41	60 (49, 80)
Time till Surgery (Months)	41	
< 1		13 (32)
1-4		3 (7)
4-8		4 (10)
8-12		1 (2)
12+		20 (49)
Not sure		0 (0)
Number of Joints to be Replaced	41	
1 joint		34 (83)
2 joints at different times		6 (15)
2 joints simultaneously		1 (2)
Post-Op Pain Expectations (VAS)	40	80 (70, 88)

VAS, Visual Analogue Scale

Perceptions of opioid efficacy and adverse effects

Seventy-five percent (123 of 165) of respondents perceived that opioids were more effective at managing pain, and 68% (112 of 164) believed that opioids had more side effects than other pain medications (**Table 4**). A greater proportion of patients with planned surgery believed that opioids had comparatively many more side effects than those who already had surgery (53%; 18 of 34 vs. 29%; 38 of 130). Of participants who already had their surgery, 44% (66 of 149) experienced constipation, 35% (52 of 149) felt drowsiness, and 32% (48 of 149) had no side effects from their pain medications (**Table S2.2**). Most participants expressed concerns for addiction (43%; 75 of 175), and 21% were not concerned about any adverse effects of opioids (**Table S2.3**). Interestingly, on a Likert scale, 39% (36 of 93) were not concerned at all about addiction, while 24% (22 of 93) were very concerned (**Table S2.4**). Many patients were not concerned at all about accidental overdose (54%; 49 of 91) and death (59%; 54 of 91). Participants were relatively the most concerned about constipation (53%; 49 of 92). As much as 88% (160 out of 182) of the participants recalled being informed about opioids from news outlets, social media, or through word of mouth.

Receptivity to opioid-free and opioid-reduced postoperative care

Forty percent (74 of 187) of participants indicated being receptive to opioid-free postoperative care, and 50% (91 of 182) endorsed that they would be open to opioid-reduced postoperative care (**Table 4**). A greater proportion of participants indicated that they would definitely not be open to receiving opioid-free care (32%; 59 of 187) compared to opioid-reduced care (24%; 43 of 182). Likewise, compared to those with a planned

surgery, more participants with their surgery completed indicated they would probably or definitely not be open to opioid-free (52% vs 19%) and reduced postoperative programs (35% vs 9%). A greater percentage of participants who had a scheduled surgery were unsure if they would be open to opioid elimination (37% vs 10%) and opioid reduction (43% vs 15%) compared to those who had already received TJA.

In the questions with open responses, a majority of participants delineated that they were open to receiving opioid elimination (42%; 15 of 36) and reduction (48%; 19 of 40) after surgery as they had previously experienced or were concerned with the adverse effects of opioid use (e.g., constipation, addiction, falls, etc.) (**Table S2.5, Table S2.6**). Thirty-six percent (13 of 36) of respondents indicated that they did not want to or need to use opioids to manage their pain, and 25% (10 of 40) believed that their pain was manageable with fewer opioids. On the contrary, 62% (48 of 78) of participants who were not open to postoperative opioid elimination and 49% (23 of 47) not receptive to opioid reduction believed that they could not tolerate pain without or with less opioids. Participants, regardless of their willingness for opioid reduction/elimination, were uncertain of non-opioid alternatives and whether they would be effective in managing their pain. Respondents who were hesitant about opioid-free/reduced care also believed that opioids were needed for better sleep, mobility, and rehabilitation, as they “could get a lot of work done as opposed to sitting around moaning and groaning” and felt that “it was like having a holiday from the pain” (**Table S2.7**). Likewise, three participants expressed anger towards their surgeon as they believed that surgeons were too restricted in prescribing opioids. Two of these patients also believed that they lacked autonomy in deciding how they wanted to

manage their pain stating, “that it is a patient's decision whether the risks and side effects outweigh the benefits...”.

In our final adjusted regression models, the odds of being open to opioid-free postoperative care are greater for those who believe that “other medications work the same or better than opioids” (OR 3.4; 95% CI: 1.4 to 8.3) compared to those who believe that “opioids work better”, and for those who perceive that “opioids have more side effects” (OR 4.3; 95% CI: 1.8 to 11.9) compared to those who believe that “other medications have the same or more side effects” (**Table 5**). The odds of being open to opioid-reduced surgery are greater for patients who believe that “opioids have more side effects” (OR 3.4; 95% CI: 1.5 to 7.9) and for those who did not report using opioids at the time of the survey completion (OR 2.5; 95% CI: 1.0 to 6.4) (**Table 6**). The variance inflation factors were less than two for each independent variable in both models, suggesting no issues with multicollinearity. The Hosmer–Lemeshow test demonstrated a good fit of both models (opioid avoidance: p-value = 0.18; opioid reduction: p-value = 0.25).

Table 4 Perceptions on opioid efficacy and safety, and openness to opioid-reduced/free postoperative care

Perception	Surgery Planned (N)	n (%)	Surgery Complete (N)	n (%)	Overall (N)	Overall n (%)
Efficacy of opioids vs other PM	33		132		165	
Opioids work much better		13 (39)		62 (47)		75 (45)
Opioids work a bit better		12 (36)		36 (27)		48 (29)
They work about the same		5 (15)		24 (18)		29 (18)
Other PM work a bit better		2 (6)		4 (3)		6 (4)
Other PM work much better		1 (3)		6 (5)		7 (4)
Side effects of opioids vs other PM	34		130		164	
Opioids have many more side effects		18 (53)		38 (29)		56 (34)
Opioids have a few more side effects		10 (29)		46 (35)		56 (34)
Side effects are about the same		5 (15)		43 (33)		48 (29)
Other PM have a few more side effects		1 (3)		1 (1)		2 (1)
Other PM have many more side effects		0 (0)		2 (2)		2 (1)
Open to opioid-free post-op care	41		146		187	
Definitely yes		9 (22)		31 (21)		40 (21)
Probably yes		9 (22)		25 (17)		34 (18)
Not sure		15 (37)		14 (10)		29 (16)
Probably no		5 (12)		20 (14)		25 (13)

Definitely no	3 (7)	56 (38)	59 (32)
Open to opioid-reduced post-op care	35	147	182
Definitely yes	10 (29)	36 (24)	46 (25)
Probably yes	7 (20)	38 (26)	45 (25)
Not sure	15 (43)	22 (15)	37 (20)
Probably no	1 (3)	10 (7)	11 (6)
Definitely no	2 (6)	41 (28)	43 (24)

PM = Pain Medications; post-op = post-operative

Table 5 Factors associated with openness to opioid avoidance after surgery

Predictor	OR	95% CI	p-value
Adverse effects			
Other medications have the same or more side effects	Ref	—	
Opioids have more side effects	4.34	1.76, 11.9	0.002
Opioids efficacy			
Opioids work better	Ref	—	
Other medications work better or the same	3.39	1.44, 8.33	0.006
Surgery planned or completed			
TJA Planned/Scheduled	Ref	—	
TJA Completed	0.90	0.37, 2.26	0.8
Highest level of education			
Less than high school	Ref	—	
High school graduate	2.79	0.73, 12.5	0.15
Post-secondary qualification(s)	1.58	0.46, 6.50	0.5
Other joint pain			
No	Ref	—	
Yes	0.69	0.32, 1.48	0.3
Current opioid use			
Yes	Ref	—	
No	2.46	0.93, 7.24	0.081
Knee vs hip replacement			
TKA	Ref	—	
THA	1.84	0.65, 5.19	0.2

Ref = Reference, OR = Odds Ratio, CI = Confidence Interval, bolded = $p < 0.05$

Table 6 Factors associated with openness to opioid reduction after surgery

Predictor	OR	95% CI	p-value
Adverse effects			
Other medications have the same or more side effects	Ref	—	
Opioids have more side effects	3.40	1.53, 7.91	0.003
Opioids efficacy			
Opioids work better	Ref	—	
Other medications work better or the same	2.00	0.85, 4.88	0.12
Surgery planned or completed			
TJA Planned/Scheduled	Ref	—	
TJA Completed	1.22	0.46, 3.22	0.7
Highest level of education			
Less than high school	Ref	—	
High school graduate	2.58	0.77, 9.23	0.13
Post-secondary qualification(s)	1.20	0.40, 3.75	0.7
Other joint pain			
No	Ref	—	
Yes	0.67	0.31, 1.40	0.3
Current opioid use			
Yes	Ref	—	
No	2.50	1.04, 6.35	0.045
Knee vs hip replacement			
TKA	Ref	—	
THA	1.76	0.65, 4.99	0.3

Ref = Reference, OR = Odds Ratio, CI = Confidence Interval, bolded = $p < 0.05$

DISCUSSION

Main findings

As safer opioid prescribing, while optimizing pain control, is an important concern for orthopedic surgeons, it is imperative to gain insight into patient knowledge and understanding of opioid use to enhance care. The present study aimed to investigate the attitudes and perceptions of patients towards opioid-free and opioid-reduced post-surgical care. Forty percent and 50% of participants reported willingness to receive TJA without or with reduced opioids, respectively. There were differences in receptivity to opioid reduction/elimination among participants who already had surgery versus those who did not. Notably, patients who believed that "other medications work the same or better than opioids" were more likely to be open to receiving opioid-free postoperative care. Those who perceived that "opioids have more side effects compared to other medications" were more likely to be receptive to both opioid-free and opioid-reduced postoperative care. Participants who were not using opioids at the time of survey completion were more likely to be receptive to opioid reduction but not opioid elimination after TJA. Individuals who were unwilling to accept an opioid-reduced/eliminated protocol believed that there is severe and intolerable pain after TJA that warrants need for opioid medications. In contrast, those who endorsed willingness to undergo opioid-free and opioid-reduced care had either encountered or were apprehensive about the adverse effects of opioids. Most participants expressed uncertainty regarding non-opioid alternatives and their effectiveness in managing their pain, and perceived that opioids were more effective, but accompanied by more side-effects compared to other pain medications. While a majority of participants

expressed concerns about addiction, the degree of concern among participants varied greatly.

Relevant literature

A cross-sectional study conducted on 85 patients undergoing orthopedic shoulder surgery in the USA revealed that approximately 76% of patients believed that they should be prescribed opioids after their surgery⁴². However, our findings indicate that 60% of participants want at least some opioids postoperatively, despite TKA and THA being relatively more painful than orthopaedic shoulder surgery⁴³. Similarly, a survey of 727 respondents on opioid use reported that 46% of patients preferred non-opioid pain medications after elective orthopedic surgery⁴⁴. Our study revealed that 50% of patients were willing to receive opioid-reduced postoperative care where a multimodal approach would be used, consistent with the findings of the two aforementioned studies. The majority of patients who were not open to the idea of opioid-free/reduced care expected an intolerable or severe level of postoperative pain, thus, requiring opioid analgesics. Patients who had surgery scheduled or planned expected to experience severe pain the first few days after their surgery. These findings are consistent with those from a qualitative study, including 11 opioid-naive patients undergoing elective knee arthroscopy, which reported that participants' attitudes toward postoperative pain and opioids were influenced by perceived tolerance to pain based on personal experience³⁵. A prospective cohort study of 259 surgical patients exhibited that patients with a high self-perceived pain tolerance may be better prepared to manage post-surgical pain⁴⁵. Conversely, those who perceive themselves as having a low pain tolerance may experience more anxiety and view pain as

a threat, potentially leading to negative psychological adjustments such as catastrophic thinking^{35,45}. Subsequently, heightened anxiety about pain and catastrophic thinking in the preoperative period may increase postoperative pain intensity⁴⁶⁻⁴⁸. As prior research has found that postoperative pain is a primary concern for up to 80% of patients preoperatively, preoperative counseling and education can improve patients' knowledge and ease their anxieties surrounding postoperative pain management⁴⁹.

Seventy-four percent of respondents believed that opioids are more effective at managing pain compared to other pain medications. A cross-sectional study of adults at the ED reported that 88% of patients who had previously used opioids found them effective at relieving pain, and 63% would take them again³¹. Despite this belief, several studies report that postoperative opioid use may be associated with lower patient satisfaction, reduced physical function, and increased pain intensity^{44,50-53}. Our multivariable analyses revealed that patients who believed that alternative medications were equally or more effective than opioids were more likely to be receptive to opioid-free postoperative care but not opioid-reduced care. This preference may be driven by concerns about the potential side effects of opioids, as any amount of opioids might be perceived as unnecessary if other medications can provide similar or better pain relief. A qualitative study of 34 participants in a trial comparing the benefits and harms of opioid versus non-opioid medications for chronic musculoskeletal pain found that a considerable number of patients held strong beliefs about the comparative effectiveness and risks of opioid versus non-opioid medications, and some patients reported changes in these beliefs over time⁵⁴. For example, some patients in the opioid group showed disappointment with the outcomes following opioid use, while those

in the non-opioid group were surprised at the effectiveness of alternative modalities. The results of our study align with these qualitative findings, demonstrating that patients perceive opioids as more effective but less safe than nonopioid medications.

Furthermore, our study revealed that patients who were not currently using opioids at the time of participation displayed more openness to opioid-reduced postoperative care. However, we did not find a significant association between this factor and willingness to pursue opioid-free postoperative care. This suggests that while patients not currently using opioids may be more receptive to reducing their opioid intake, they may still harbor reservations about eliminating opioids from their postoperative pain management regimen. This hesitancy could potentially be attributed to their past exposure to opioids. However, our study did not collect data on participants' past opioid use, which could serve as a confounding variable. To shed light on this aspect, a retrospective study utilizing TRICARE claims data from 2006 to 2014 reported that prior exposure to opioids, within six months before TJA, was a significant predictor of a lower likelihood of opioid discontinuation (hazard ratio: 0.65, 95% CI: 0.62 to 0.67)⁹. A systematic review and meta-analysis of 30 studies assessing persistent postoperative opioid use after TKA and THA found that over 20% of patients continued opioid use for longer than three months, and opioid naïve patients were less likely to have persistent postoperative opioid use⁵⁵. Future studies can address this limitation by including a comprehensive assessment of patients' past opioid use, enabling a better understanding of the factors shaping their decision-making processes.

Many patients stated that they were open to opioid-free or opioid-reduced postoperative programs due to their previous negative experiences or apprehension regarding the adverse effects associated with opioid use or simply because they preferred to avoid opioid pain medications altogether. Likewise, a cross-sectional study on the perceptions of ED patients reported that experiencing adverse effects made patients less likely to use opioids again (OR 0.703; 95% CI: 0.659, 0.751)³¹. In line with these findings, our multivariable logistic regression analyses revealed that patients who thought that opioids had more adverse effects than other medications were more amenable to both opioid reduction and avoidance. In our study, 68% of patients who had undergone TJA experienced at least one side effect from the pain medications they used postoperatively. Patients almost unanimously understood that opioids are harmful and identified addiction as the most concerning side effect. Surprisingly, 39% of participants reported being “not concerned at all” about addiction when asked to rate their level of concern on a Likert scale. Constipation was the side effect that participants were “very concerned” about. Participants may have had greater familiarity with addiction and constipation due to the increased media attention that these side effects have received⁵⁴. Of patients who already had surgery, most (44%) reported experiencing constipation as a result of their pain medications. The prevalence of opioid-induced constipation among patients with chronic non-cancer pain ranges from 41% to 81%, which may explain the high level of concern patients have for this adverse effect⁵⁶. Interestingly, only 3% of participants identified death as their primary concern, and 59% reported that they were “not concerned at all” on a Likert scale. Similarly, another cross-sectional study of 715 ED participants reported that although 78% of

participants recognized opioid abuse as a public health concern, they underestimated the prevalence of opioid-related deaths³¹. As a majority of our survey respondents were elderly, it may be possible that they may have perceived addiction as something they have more control over compared to death. However, a decrease in elderly patients' ability to metabolize opioids, a decline in cognitive function, social isolation, and depression may contribute to the increasing prevalence of fatal overdoses⁵⁷. Despite this, a majority of patients did not express concerns regarding opioid-related death. Further research is warranted to explore the interplay between age-related factors and perceptions of opioid use and risks.

Another cross-sectional study surveying the perceptions of orthopaedic trauma patients found employment, knowing someone who was dependent or overdosed on opioids, and higher education level to be associated with a better understanding of opioid efficacy and safety³⁰. Building upon these findings, our study further found an association between patients' perceptions of opioid safety and efficacy and their openness to opioid-free and reduced postoperative protocols. However, unlike the previous study, we did not find education level to be a significant factor in our adjusted models, and we did not gather information on employment and knowing others with a history of dependence/overdose in our questionnaire. It is essential to acknowledge that pain is a multifactorial experience, and its association with pain medication use is complex and may be compounded by patient beliefs, experiences, physiological factors, and systemic factors, among others.

Limitations

Although our study provides important insights into patients' perceptions of opioids, several limitations should be considered. First, the sample primarily consisted of TKA patients, females, those who understood English, and had already undergone surgery. Additionally, the study was only conducted at two clinics in Hamilton, which may limit the generalizability of findings to other populations and regions. Also, we did not document the total number of individuals approached during the recruitment process or the number of participants who declined to take part in the study. Due to logistical issues and institutional constraints in conducting in-person research stemming from the COVID-19 pandemic, only 200 participants were recruited, of which 190 completed the survey, despite initially targeting a sample size of 400. In spite of this limitation, there was a sufficient number of events in the minority class to support the number of independent variables included in each of the multivariable logistic regression models, reducing the risk of overfitting; multicollinearity was not deemed as an issue for either of our models, and both had a good fit (as indicated by the Hosmer-Lemeshow test)^{28, 37, 38}. Our study may have been impacted by recall bias as some participants had undergone surgery up to one year prior to the survey, and social desirability bias may have led to underreporting of opioid use and biased views on opioids. Furthermore, the survey used in this study was developed internally by experts at our institution and did not undergo a prior validation process, which may have resulted in an inherent bias in the question design. However, several orthopaedic surgeons and experts in pain management reviewed our questionnaire to minimize bias, prior to implementation. Although we adjusted for patient characteristics, other possibly

confounding variables may include the variability among the different types of injuries, various stages of treatment, body mass index, ethnicity, and smoking status/history. Future studies may aim to assess potential differences in perceptions based on specific types of surgeries and approaches, comorbidities, prior opioid exposure, and risk factors, not considered in this present study. Additionally, subsequent studies can investigate whether cultural and ethnic factors play a role in patients' perceptions of opioids and their willingness to accept alternative pain management strategies⁵⁸. The findings from such studies could help identify potential disparities in pain management and inform culturally sensitive approaches to address patient needs.

Implications

The findings of our study underscore the importance of preoperative patient education and discharge instructions consisting of information about the efficacy and safety of opioids and non-opioid alternatives. By addressing patients' psychological needs and pain expectations through preoperative education, it may be possible to reduce postoperative recovery time and intensity of acute pain. This, in turn, could reduce opioid prescriptions, potentially lowering the risk of chronic postsurgical pain⁴⁶. A qualitative study of 11 opioid-naive patients undergoing elective knee arthroscopy reported that every participant expressed that preoperative counselling and education regarding postoperative pain management would be beneficial in improving their knowledge, decreasing anxieties, and clarifying misunderstandings³⁵. As a considerable number of patients scheduled for surgery expressed uncertainty about their openness to opioid-free or reduced postoperative care, it is important to focus on preoperative education to inform them about the potential adverse

effects of opioids and the efficacy of alternative pain management strategies, which may make them more amendable to these efforts. A shared decision-making model that incorporates patient education on appropriate expectations of pain control, risks and benefits of opioid pharmacotherapy and alternatives, and instructions for disposal of leftover medications can significantly decrease the number of opioid tablets patients require while retaining high satisfaction levels⁵⁹. Similarly, a systematic review of 11 studies found that educating patients about appropriate opioid use and pain management can be an effective way to reduce the frequency of opioid prescription requests and refills⁶⁰. However, the review also found that education focused solely on postoperative expectations may not consistently impact postoperative pain scores; orthopaedic healthcare teams should consider implementing a comprehensive education program that includes a verbal discussion of opioid use, side effects, abuse, and pain management expectations preoperatively, as a part of an over-arching multimodal approach. Additionally, providing educational handouts to reinforce the discussion may help patients retain this information⁶⁰. Given that orthopedic surgeons are some of the leading prescribers of opioids, it is important to prioritize methods to reduce the demand for opioids. Therefore, understanding patients' perceptions of postoperative opioid use and needs is critical for orthopedic surgeons to effectively contribute to mitigating the opioid crisis.

CONCLUSIONS

More patients were open to opioid-reduced postoperative care compared to opioid-free postsurgical care. Patients' receptivity to opioid-reduction and elimination protocols was

associated with their perceptions of the safety and efficacy of opioids compared to non-opioid alternatives and self-reported opioid use at the time of participation. Our study highlights the need for a more comprehensive and tailored educational approach that focuses on the safety and efficacy of opioids and other alternatives, and patients' expectations for postoperative pain control. By addressing patients' concerns and misconceptions regarding opioids, healthcare providers can better support patients in making informed decisions about their pain management.

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APPENDICES/SUPPLEMENTARY INFORMATION

Appendix 2-A Questionnaire assessing patients’ perceptions on opioid efficacy and safety, and receptivity to opioid-free and opioid-reduced surgery

Part A: Participant Characteristics

Date _____

What is your gender? Male
 Female
 Other/prefer not to say


What is your age in years? _____

What is your highest level of education? No high school
 Some high school
 High school completed
 College/trade school
 Bachelor's degree
 Master's degree
 Doctorate degree

What is your household income? Under \$20,000
 \$20,000-\$40,000
 \$40,000-\$60,000
 \$60,000-\$80,000
 \$80,000-\$100,000
 over \$100,000

Have you or will you be having total hip or total knee replacement surgery? Total knee replacement surgery
 Total hip replacement surgery

Will you be receiving or have received direct anterior hip replacement surgery? Yes
 No
 Unsure

Please rate your level of joint pain today No pain Moderate pain Unbearable pain

(Place a mark on the scale above)

For how long have you had joint pain? 0 - 1 year
 2 - 3 years
 4 - 5 years
 6+ years

Do you have any chronic joint pain other than your knee or hip that will be/has been replaced? Yes
 No

Specify where (check all that apply)

- My other knee
- My other hip
- Knee(s)
- Hip(s)
- Ankle(s)
- Shoulder(s)
- Elbow(s)
- Wrist(s)
- Hand(s)
- Neck
- Back
- Other

Specify the joint _____

Are you currently taking pain medications for joint pain (prescription or non-prescription)?

Yes
 No

Which pain medications are you currently taking for joint pain (prescription or non-prescription)?

- Naproxen (Naprosyn, Aleve)
- Toradol (Tramacet, Ketoralac)
- Celecoxib (Celebrex)
- Diclofenac (Arthrotec, Voltaren, PennSaid)
- Indomethacin (Indocin)
- Meloxicam (Mobic)
- Codeine (Tylenol 3)
- Morphine
- Oxycodone (Percocet, OxyContin)
- Hydromorphone (Dilaudid, Hydromorph Contin)
- Fentanyl
- Gabapentin (Neurontin)
- Pregabalin (Lyrica)
- Amitriptyline (Elavil)
- Cannabis (marijuana, CBD, THC)
- Ibuprofen (Advil, Motrin)
- Aspirin
- Acetaminophen (Tylenol)
- I don't remember
- Other

Specify other _____

Have you had your joint replacement surgery yet?

No, my joint replacement is planned/scheduled
 Yes, I had a joint replacement in the past year
 I have had one joint replaced already and the other joint replacement is planned/scheduled

Part B: For patients who have already had their joint replaced

How long ago did you have your joint replacement surgery?

Less than one month ago
 1-3 months ago
 3-6 months ago
 6-12 months ago

Did you have one joint replaced or both?

One joint
 Two joints at different times
 Two joints at the same time

Is your joint pain today better or worse than before surgery?

Much better
 A bit better
 About the same
 A bit worse
 A lot worse

Remember back to the first few days after your joint replacement surgery. How painful was it?

No pain Moderate pain Unbearable pain
 =====
 (Place a mark on the scale above)

How satisfied were you with your pain medications while you were in the hospital?

Not at all satisfied Moderately satisfied Completely satisfied
 =====
 (Place a mark on the scale above)

How satisfied were you with your pain medications after you went home from the hospital?

Not at all satisfied Moderately satisfied Completely satisfied
 =====
 (Place a mark on the scale above)

Did you experience any of these side effects from your pain medications after surgery?

Addiction
 Nausea/Vomiting
 Constipation
 Drowsiness
 Lack of coordination
 Inadequate pain control
 Liver toxicity
 Accidental overdose
 Other
 No side effects

Specify other _____

Opioids are pain medications that are commonly prescribed after surgery. Common opioids include Tylenol 3 (codeine), morphine, Dilaudid and Hydromproh Contin (hydromorphone), OxyContin, OxyNEO and Percocet (oxycodone).

If you had to do it again, would you be willing to have joint replacement surgery without opioid pain medications? Your doctor would offer you other pain medications that do not contain opioids.

Definitely yes
 Probably yes
 Not sure
 Probably no
 Definitely no

Why or why not? _____

If you had to do it again, would you be willing to have joint replacement surgery with a lower dose of opioid pain medications? Your doctor would offer you other pain medications that do not contain opioids.


Definitely yes
 Probably yes
 Not sure
 Probably no
 Definitely no

Why or why not? _____

Part C: For patients who have not yet had their joint replaced

When will your joint replacement surgery be? In less than one month
 In 1-4 months
 In 4-8 months
 In 8-12 months
 More than 12 months away
 I'm not sure

Will you have one joint replaced or both? One joint
 Two joints at different times
 Two joints at the same time

How much pain do you expect that you will have in the first few days after surgery? No pain Moderate pain Unbearable pain

(Place a mark on the scale above)

Opioids are pain medications that are commonly prescribed after surgery. Common opioids include Tylenol 3 (codeine), morphine, Dilaudid and Hydromproh Contin (hydromorphone), OxyContin, OxyNEO and Percocet (oxycodone).

If your doctor asked you, would you be willing to have joint replacement surgery without opioid pain medications? Your doctor would offer you other pain medications that do not contain opioids. Definitely yes
 Probably yes
 Not sure
 Probably no
 Definitely no

Why or why not? _____

If you had to do it again, would you be willing to have joint replacement surgery with a lower dose of opioid pain medications? Your doctor would offer you other pain medications that do not contain opioids. Definitely yes
 Probably yes
 Not sure
 Probably no
 Definitely no

Why or why not? _____

Part D: For all patients

Opioid pain medications have been in the news a lot lately. Have you heard about opioids on the news, on social media, or from your friends? Yes
 No
 Not sure

How well do you think opioid pain medications control pain compared to other types of pain medications? Opioids work much better
 Opioids work a bit better
 They work about the same
 Other medications work a bit better
 Other medications work much better

Do you think opioids have more side effects compared to other pain medications? Opioids have many more side effects
 Opioids have a few more side effects
 Side effects are about the same
 Other pain medications have a few more side effects
 Other pain medications have many more side effects

When taking opioid medications, how concerned are you about the following side-effects?

	Not concerned at all	Not really concerned	Neither concerned or unconcerned	Concerned	Very concerned
Addiction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nausea/Vomiting	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Constipation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Drowsiness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of coordination	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Inadequate pain control	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Liver toxicity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Accidental overdose	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Death	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

When taking opioid pain medications, which side effect are you worried about the most? (please select one only)

- Addiction
- Nausea/Vomiting
- Constipation
- Drowsiness
- Lack of coordination
- Inadequate pain control
- Liver toxicity
- Accidental overdose
- Death
- Other
- Not concerned about any side effects

Specify other _____

Other Comments

Do you have any more comments for us? (optional) _____

Table S2.1 Other reported locations of joint pain and prescription and non-prescription medication use

Characteristic	N	n (%)
Other Joint Pain	188	110 (59)
Other knee		65 (35)
Other hip		3 (2)
Knee(s)		5 (3)
Hip(s)		23 (12)
Ankle(s)		11 (6)
Shoulder(s)		19 (10)
Elbow(s)		4 (2)
Wrist(s)		8 (4)
Hand(s)		13 (7)
Neck		10 (5)
Back		27 (14)
Other		6 (3)
Currently Using Pain Medications	189	141 (75)
Naproxen		17 (9)
Toradol		5 (3)
Celecoxib		14 (7)
Diclofenac		17 (9)
Indomethacin		1 (0.5)
Meloxicam		3 (2)
Codeine		9 (5)
Morphine		9 (5)
Oxycodone		8 (4)

Hydromorphone	19 (10)
Fentanyl	0 (0)
Gabapentin	5 (3)
Pregabalin	3 (2)
Amitriptyline	0 (0)
Cannabis	6 (3)
Ibuprofen	24 (13)
Aspirin	5 (3)
Acetaminophen	83 (44)
I don't remember	5 (3)
Others	9 (5)

Table S2.2 Adverse effects to pain medications encountered by patients who had undergone surgery

Adverse Effect	n (%) (N=149)
Constipation	66 (44)
Drowsiness	52 (35)
No side effects	48 (32)
Inadequate pain control	24 (16)
Nausea/vomiting	22 (15)
Lack of coordination	17 (11)
Accidental overdose	1 (1)
Addiction	1 (1)
Liver toxicity	0 (0)

Table S2.3 Side-effect of opioids that patients are most concerned about in relation to the others

Characteristic	n (%) (N=175)
Addiction	75 (43)
Not concerned about any side effects	36 (21)
Constipation	22 (13)
Liver toxicity	11 (6)
Nausea/Vomiting	9 (5)
Lack of coordination	5 (3)
Death	5 (3)
Drowsiness	4 (2)
Inadequate pain control	3 (2)
Other	3 (2)
Accidental overdose	2 (1)

Table S2.4 Patients' level of concern for the adverse effects of opioids

Characteristic	N	Not concerned at all¹	Not really concerned¹	Neither concerned or unconcerned¹	Concerned¹	Very concerned¹
Addiction	93	36 (39)	10 (11)	6 (6.5)	19 (20)	22 (24)
Nausea/Vomiting	93	39 (42)	21 (23)	11 (12)	15 (16)	7 (7.5)
Constipation	92	17 (18)	11 (12)	15 (16)	34 (37)	15 (16)
Drowsiness	93	32 (34)	19 (20)	17 (18)	22 (24)	3 (3.2)
Lack of coordination	92	38 (41)	16 (17)	17 (18)	17 (18)	4 (4.3)
Inadequate pain control	90	41 (46)	14 (16)	7 (7.8)	18 (20)	10 (11)
Liver toxicity	93	38 (41)	11 (12)	10 (11)	21 (23)	13 (14)
Accidental overdose	91	49 (54)	12 (13)	7 (7.7)	13 (14)	10 (11)
Death	91	54 (59)	7 (7.7)	10 (11)	7 (7.7)	13 (14)

¹n(%)

Table S2.5 Themes and sub-themes of patient responses to reasons for openness to opioid avoidance

Themes and Sub-Themes	Frequency of Endorsement n (%)	Examples of Patient Responses
Open to Receiving Opioid-Free Postoperative Care (N = 36)		
Experienced or concerned about adverse effects of opioids	15 (42)	“To avoid constipation, and also pain was not that bad”, “Don't like the side effect”
Opioids lack efficacy in managing pain	2 (6)	“[Opioids] did not work for me”, “Unable to tolerate morphine”
Does not want/need to use opioids for managing pain	13 (36)	“Hardly used any of the meds”, “Don't like to take really any drugs for pain”, “Do not want them in my body”
Knowledge gaps		
Pain expectations after surgery	1 (3)	“I didn't know what to expect”
Efficacy of non-opioid alternatives	2 (6)	“If there is a 'good' alternative it makes sense not to be reliant on opioids”, “Yes, as long as they were effective”
Satisfied with non-opioid alternatives	3 (8)	“Patient is okay with just Tylenol”
Unable to monitor rehabilitation (pain is masked)	1 (3)	“Rehab could be compromised if the pain is masked also I'm not a fan of opioids”
Not Open to Receiving Opioid-Free Postoperative Care/Not Sure (N = 78)		
Intolerable level of pain without opioids	48 (62)	“Can't tolerate the pain without”, “Pain is unbearable”
Faster and better pain relief with opioids	6 (8)	“Very good pain relief from opioids and there was a lot of pain after surgery. Morphine helped more but didn't receive diff doses.”
Knowledge gaps		
Efficacy of non-opioid alternatives	11 (14)	“Not sure what pain level would be like without them”, “I don't know that there is anything that would work as well”

Strategies to manage pain immediately after discharge	1 (1)	“Need better info on immediate pain meds requirements after 72 hours”
Weaning off opioids after use	1 (1)	“Helpful if they are only given opioids for a little time and help with getting off of it. Hard to get off hydrocodone even after one week and it causes many side effects. Need something to naturally and gently stop opioid use.”
Concerned about adverse effects	3 (4)	“Pain was horrendous and was conscious of addictive nature”, “Fear of addiction and mental illness associated”
Expectation of being pain free	7 (9)	“Not enough pain management”, “Don't want pain”
Need opioids for better sleep, increased mobility and rehabilitation	5 (6)	“Really needed them for the pain and to do the exercises”, “Physiotherapy is hard and it pushes patient and they would be in extreme pain after physio”
Positive experience/outcomes after past opioid use	5 (6)	“I know they are effective after surgery from my past experiences. I don't want to try something that may not work”

Table S2.6 Themes and sub-themes of patient responses to reasons for openness to opioid reduction

Themes and Sub-Themes	Frequency of Endorsement n (%)	Examples of Patient Responses
Open to Receiving Opioid-Reduced Postoperative Care (N = 40)		
Experienced or concerned about adverse effects of opioids	19 (48)	“Don't want to be hooked”, “Find that medication changes your personality and can be addictive”
Pain is/was manageable with less opioids	10 (25)	“Hardly used any of the meds”, “Pain was manageable without opioid as time went on”
Lack of knowledge about efficacy of non-opioid alternatives	3 (8)	“Need to know what is it, and how effective it is. Discuss.”
Reduced opioids allow for mobility and rehabilitation	2 (5)	“It's definitely hard to do physio without pain meds”, “So, I can walk”
Cannot tolerate pain with no opioids	3 (8)	“To control pain but lessen risk of addiction”, “Pain was intense, don't want to suffer”
Does not want/need to use opioids for managing pain	4 (10)	“Do not want them”, “Prefer no opioids”
Not Open to Receiving Opioid-Reduced Postoperative Care/Not Sure (N = 47)		
Need more opioids to control/tolerate pain	23 (49)	“Because if anything I need stronger pain medication”, “Pain is too intense”
Already using a low dose/amount	3 (6)	“Already low dosage would not like any lower”, “Taking minimum now”
Lack of knowledge about efficacy of non-opioid alternatives	9 (19)	“Depends on whether the substitutes control the pain as well”, “Only if I was ASSURED that they would work effectively”
Expectation of being pain free	4 (9)	“I want pain gone”, “Pain wasn't taken away initially”
Dissatisfied with pain management medications	1 (2)	“Medication was not as effective as previous surgery”
Need more opioids for increased mobility and rehabilitation	5 (11)	“Needed medication for exercise and physio want more not less”, “If you have to do everything yourself you need meds”

Table S2.7 Themes and sub-themes of patients’ additional comments and thoughts

Themes and Sub-Themes	Frequency of Endorsement n (%) (N=46)	Examples of Patient Responses
Experienced or concerned about adverse effects	11 (24)	“They worked, just side effects were strong and needed to be taken off. Addiction was in front of mind to decrease the dosage”, “Opioids make me feel "very off" like I wasn't myself. If another option provided the same pain relief I would be very willing to try it”
Many opioids leftover/did not use opioids	4 (9)	“Hardly used the medications and for short time”, “I took the prescribed opiates for a few weeks then just went to Tylenol”
Cannot tolerate pain without opioids	4 (9)	“Opioid control is essential during immediate post-op period 24-72 hrs. After that non-opioids is quite adequate”, “When nurse comes and asks what pain it is, do not say you do not have any since they give you none. When block wears off you are in so much pain it becomes difficult to get rid of pain afterwards”
Has not had negative experiences/outcomes with opioids	1 (2)	“Didn't have any negative experiences with opioids and they should give it to people that need it but careful screening is needed before they give it.”
Lack of patient autonomy in pain management	2 (4)	“I believe that it is a patient's decision whether the risks and side effects outweigh the benefits...”, “...I think it is important to look at a patient as an individual”
Surgeons' restrictions vs patient needs	3 (7)	“I need a higher dose and doctors are too reluctant to prescribe. It angers me to no end!”, “I understand that doctors worry about addiction however some patients such as myself need proper pain control and unfortunately for me hydromorphone did not help me.”
Satisfied with surgery, less opioids, and outcomes	5 (11)	“Tylenol worked for me instead of opioids”, “I was very pleased with my surgery and I made sure that I did my exercises that I was taught at physio for the time that I was waiting for surgery, and I made sure I did everything I was told to do after surgery also”
Need for safe and effective alternatives	6 (13)	“I wish there was a strong medication for pain that does not cause nausea, dizziness + general malaise, the side effects of hydromorphone are

		awful”, “Need better plan rather than opioids and it needs to be something that's not addictive or that aggressive...”
Need for better strategies to wean off of opioids	1 (2)	“Need a more gentler method for patients to get off of opioids after they are done their prescription so it's not so abrupt”
Opioids needed for better sleep, mobility, and rehabilitation	9 (20)	“Other than knee surgery - I used to have Percocet handy for chronic knee pain - bad for constipation, but very good for pain management. When I took a dose, I could get a lot of work done as opposed to sitting around moaning and groaning. I was not addicted, but it was like having a holiday from the pain”
Increased monitoring needed to decrease risk of side-effects	4 (9)	“When managed properly side effects can be avoided”, “Most of the side effects are if meds aren't taken properly”
Opioids are more effective than alternatives for pain control	1 (2)	“Opioids help more than any other pain medications I’ve tried...”
Opioids are unnecessary/should be banned	4 (9)	“Overall don't take any medications so prefer to stay off everything”, “Tell the doctor to stop giving it to patients”, “Should be banned”

**Chapter 3: Perceptions on opioid prescribing after total joint arthroplasty among
orthopedic surgeons practising in Canada, Japan, and the Netherlands: A
qualitative description study**

ABSTRACT

Background: Opioid analgesics are commonly prescribed after total knee and hip arthroplasty to manage pain, but they are typically not more effective than alternatives and are associated with important harms. Rates of opioid prescribing after arthroplasty differ by country suggesting differences in policies or surgeons' perceptions.

Methods: We adopted a qualitative description design to compare the perceptions of Canadian, Dutch, and Japanese orthopaedic surgeons on postoperative opioid prescribing and to explore facilitators and barriers to opioid reduction. We used a combination of convenience and purposive sampling, and a snowball recruitment technique to facilitate 27 semi-structured interviews online or via a phone call. We concurrently collected and analyzed data using conventional (inductive) content analysis.

Results: Surgeons in Canada and the Netherlands prescribed opioids to 100% (IQR 0 and 90-100, respectively) of their arthroplasty patients postoperatively, compared to 65% (IQR 8.6-100) of patients in Japan. Japanese surgeons relied on non-opioid analgesics as they believed that opioids were often unnecessary for managing post-operative pain. While all Dutch surgeons utilized an institutional standard pain management protocol, Canadian and Japanese surgeons exhibited high variability in opioid prescribing, even within the same institution. Orthopaedic surgeons in each country identified challenges and facilitators to reduced postoperative opioid use in 6 key areas: (1) opioid prescribing practices, (2) patient factors, (3) collaborative care, (4) opioid prescribing policies/guidelines, (5) surgeon education, and (6) personal perceptions/beliefs.

Conclusions: Canadian and Dutch surgeons are more likely to prescribe opioids after arthroplasty, compared to Japanese surgeons. Further, Canadian surgeons report high variability in duration and dose of opioids prescribed compared to surgeons from other countries. Our findings suggest opportunities for standardization of opioids after joint replacement surgery.

Keywords: Opioid medication; opioid dependence; knee arthroplasty; hip arthroplasty; surgeon perceptions; provider education; pain management; qualitative study

INTRODUCTION

Due to an aging population and increased prevalence of obesity, OA is a burgeoning public health issue that poses a substantial economic burden for individuals and society, projected to increase¹. While many interventions are available for managing OA, TJA is a standard procedure to manage end-stage disease. Approximately 29% of THA and 51% of TKA patients report moderate to severe acute pain following surgery². Accordingly, opioids are often prescribed in the acute postoperative period after joint replacement surgery in many countries³.

However, the increase in opioid prescribing over the years has fuelled the current opioid crisis in some countries, referring to the increase in the incidence of deaths and hospitalizations resulting from the increasing use of prescription and non-prescription opioids⁴. Opioids can have unwanted effects including nausea, lethargy, respiratory depression, sedation, urinary retention, drug induced hypotension, and falls⁵. Use of opioids at higher doses or longer durations may result in physical dependence, and is associated with addiction, overdose, and even death. In 2017, 40.5 million people experienced opioid dependence and approximately 110,000 people died from opioid overdose globally⁶. Considering that orthopaedic surgeons are the third-highest opioid prescribers in the USA and are responsible for approximately 60% of opioid prescriptions to opioid-naïve patients, it is crucial for surgeons to ensure that their prescribing patterns are concordant with current best evidence⁷. A systematic review of 38 studies found that the rate of misuse averaged between 21% and 29% among individuals consuming opioids for chronic pain relief⁸. Orthopaedic surgeons, however, may experience conflict between attempting to reduce

opioid prescriptions and providing appropriate care to patients to manage their postoperative pain. Opioid prescribing and consumption vary across countries, suggesting differences in healthcare systems, policies, and surgeon perceptions⁹⁻¹¹.

Canada

North America is at the heart of the opioid crisis, with Canada and the USA reporting the greatest per-person consumption of prescription opioids globally¹². The North American opioid crisis primarily emerged due to the insufficient regulation and profit-driven motives of the pharmaceutical and health-care industries, which nearly quadrupled opioid-prescribing¹². As each wave of the opioid crisis augmented the previous one, the third wave commenced in 2014, and was predominantly characterized by an upsurge in addiction and fatal overdoses related to synthetic opioids. There were 22,828 deaths from opioid toxicity between 2016 and 2021 in Canada, with 6,946 deaths occurring during the COVID-19 pandemic between April 2020 to March 2021¹³.

The Netherlands

In the Netherlands, between 2008 and 2017, the cumulative number of opioid prescriptions nearly doubled, with a concordant increase in misuse¹⁴. Data from a 2018 report by the International Narcotics Control Board indicated that the Netherlands is currently ninth globally in terms of the daily dosages of opioids per million inhabitants per day (with 16,114 defined daily dosages per one million inhabitants), while the USA and Canada are in first and third place, respectively. Opioid misuse in the Netherlands is substantially lower than in North America, including opioid-related mortality, though it is much greater than

in Japan^{14, 15}. The opioid epidemic in the Netherlands is predominantly due to easy access to opioid analgesics and aversion to non-steroidal anti-inflammatory drugs by patients, as public marketing by pharmaceutical companies is not permitted¹⁴.

Japan

In stark contrast to the devastating opioid crisis in North America, Japan's opioid use is sparse. The per capita use of six potent opioids is 26 times higher in the USA than Japan, despite a similar prevalence of chronic pain⁹. Similarly, orthopaedic surgeons in Japan prescribe significantly less postoperative opioids as compared with those in North America⁹. Japan was the first Asian country to enact legislation in the 19th century to strictly regulate opioid consumption^{9, 16}. Therefore, in the last couple of decades, Japan has not experienced substantial issues with opioid addiction and related consequences⁹. Along these lines, orthopaedic surgeons in Japan prescribe fewer postoperative opioids as compared to those in North America⁹.

Rationale and novelty

Although quantitative studies have investigated patterns of opioid prescribing among orthopaedic surgeons in various jurisdictions, there is a lack of qualitative studies exploring the perceptions of surgeons on this issue. Comparing and understanding perceptions, including facilitators and barriers to reducing use of opioids in distinct jurisdictions, may inform the willingness of surgeons to revisit their prescribing practices. It may also aid in identifying potential best practices that can be shared among countries to enhance patient outcomes and promote safer pain management practices. To our knowledge, this will be

the first qualitative research study to explore and compare the perceptions of surgeons on prescribing opioids after TJA in three jurisdictions that represent high (Canada), moderate (The Netherlands), and low (Japan) opioid prescribing practices.

PURPOSE

The purpose of this study is to adopt a qualitative description (QD) approach to explore and understand the similarities and differences in the perceptions of orthopaedic surgeons in Canada, Japan, and the Netherlands on opioid prescribing after total knee or hip arthroplasty. The secondary objectives are to explore the perceptions of (1) the possible barriers, challenges, and concerns with opioid prescribing and reduction, and (2) the facilitators of opioid reduction after TKA or THA.

RESEARCH QUESTION

What are the perceptions and practices of orthopaedic surgeons with respect to prescribing opioids after total knee and hip arthroplasty in Canada, Japan, and the Netherlands?

METHODS

Research tradition

This study used a QD design. The QD approach is commonly employed in research studies that aim to provide descriptive accounts of health care phenomena. This approach emphasizes an analytical and data-driven perspective, relying on low-inference techniques, to prioritize the practical implications of findings for healthcare providers, educators, and

policy makers¹⁷⁻²⁰. QD methodology is an optimal fit for this study as its purpose is to advance professional knowledge by providing an objective summary of the perceptions and experiences of orthopaedic surgeons in three jurisdictions on opioid prescribing. This approach emphasizes that simply understanding surgeons' perceptions to inform a theoretical framework is not the end goal²⁰. Instead, rendering the knowledge usable by applying it to inform clinical practice decisions and to the lives of real people is of paramount importance.

Sampling and recruitment

We selected three countries from which to gather data for this study. Specifically, Canada (CA), the Netherlands (NL), and Japan (JAP) were sampled as they represent high-, medium-, and low-magnitude countries, respectively, with respect to opioid prescribing by knee and hip arthroplasty orthopedic surgeons. We used convenience sampling whereby orthopaedic surgeons were recruited from an existing network in the aforementioned countries. Convenience sampling is a form of nonprobability sampling in which members of the target population who are easily accessible and available are included²¹. We recruited surgeons who understood and spoke English and routinely performed hip or knee arthroplasty. A translator was available when the surgeon indicated they would prefer one to allow for more accessible communication. We also used non-probability, purposive sampling, which allows researchers to intentionally “select” participants to provide a rich account of and had in-depth knowledge of the phenomena of interest^{20, 22}. To aid in our purposive sampling approach, we used a snowball recruitment technique where initial participants recommended additional contacts in the same country who fit the research

criteria and were willing to partake in the study. We recruited participants via our professional social media accounts (i.e. Instagram and Twitter) and email. We sought maximum variation in academic versus community practice locations, gender, and years of practice.

Sample size

In qualitative research, the projected sample size is contingent on the aim of the study, sample specificity, and quality of dialogue and is often presented as a range²³. Considering the under-representation of women in orthopaedic surgery, more interviews were necessary to acquire maximum variations in gender²⁴. Although there are no set recommendations for sample size for the QD approach, Thorne (2016) advises a sample size between five and 30 participants for an interpretive description design, which is similar to QD²². We conducted interviews with 11 Canadian, 9 Dutch, and 7 Japanese orthopaedic surgeons before we reached data saturation in which no new themes were developed from data analysis; we completed two subsequent interviews in each country to verify that data saturation was reached²⁰.

Data collection

Semi-structured interviews were used as the sole data collection method because their flexibility allows for detailed and responsive questioning and can elicit subjective insights pertaining to a particular phenomenon²⁵. The interviews explored what participants thought about opioid prescribing, and related educational and training needs and preferences. Interviews were completed between November 2022 and February 2022 and were between

15-45 minutes. Trained research assistants (MP and PP) conducted interviews virtually via Zoom or a phone call. Each interview was audio-recorded and transcribed verbatim for data analysis. To ensure confidentiality, we de-identified all data. This study was reviewed and approved by the Hamilton Integrated Research Ethics Board (Project number 15023; McMaster University).

Each interviewer developed interview field notes that captured the overall tone of the interviews, key issues identified during the discussion, and any unique features of the session. The interviewers also noted the perspectives that they brought to the research process, reflections, and emotions in a reflective journal before and after each interview. These notes assisted in the assessment of data saturation as data collection progressed. The interview team members held regular meetings to ensure consistency in the interviewing procedures. These meetings were structured around the research objectives using data collection memos prepared by the research assistants as guidance.

Interview guide

We used a semi-structured interview guide (**Appendix 3-A**). This approach is helpful as it provides participants with some guidance on what to discuss while also allowing for the exploration of issues that the researchers may not have yet considered²⁵. Specifically, our guide consisted of a series of open-ended questions intended to capture the perceptions of surgeons on opioid prescribing after TKA or THA. The research objectives, the team members' clinical experiences and perceptions of important topics, and past literature concomitantly informed the development of this interview guide^{26, 27}. The research coordinator, qualitative researchers, and several orthopaedic surgeons reviewed the

interview guide and provided feedback on the probes/questions, clarity, and comprehensiveness.

Data management

We used Dedoose (v9.0.90) for data management and analysis to allow for greater efficiency in organizing large amounts of qualitative data as this study implemented a large number of interviews, with each being approximately 15-45 minutes in length²⁸.

Data analysis

QD studies provide a low-inference and data-driven description of a phenomenon²⁰. We used conventional (inductive) content analysis as it is most optimal in the context of this study as existing theory or literature on this phenomenon is limited^{18, 29, 30}. We collected and analyzed data concurrently. We started analysis after each interview and used field notes and transcripts from the interviews to identify nascent concepts to explore in future interview discussions. As data collection proceeded, novel data and insights were incorporated into the analysis, making it reflexive and iterative²⁰.

Two research team members (MP and PP) iteratively read the transcripts to derive codes by highlighting text that captured key thoughts or concepts. During this process, the researchers also noted down their initial impressions. Subsequently, labels for codes emerged from the text and formed the initial coding scheme. We grouped the codes into categories based on their relationships and connections, which helped organize and cluster codes into meaningful groups²⁹. To ensure the reliability of the identified concepts and their overarching categories, two members (MP and PP) coded all transcripts independently and

in duplicate in a triangulated approach. The categories were then discussed with and reviewed by a qualitative researcher (AA) and field experts (KM, SS, and JB). We also captured representative quotes for the identified categories.

In order to compare and contrast the emerging themes in each jurisdiction, we used an integrated, joint, side-by-side display to display data from each country together by the research objectives³¹. Additionally, we illustrated concepts in Venn diagrams to identify similarities and differences between jurisdictions. When possible, we quantified ideas using proportions, and summarized demographic data using ranges, or mean and SD, when normally distributed, or median and IQR, if not.

Strategies to promote rigor and trustworthiness

As the latent philosophy of most qualitative research works is that the nature of reality is ontologically relativist and subjectively constructed, it is imperative to establish trustworthiness and rigour. Credibility, confirmability, dependability, and transferability underpin the principles of trustworthiness in qualitative research^{32, 33}. Credibility gauges whether the researcher and others have confidence in the truth of the findings, confirmability ensures that the research process and findings are not fraught with bias, dependability ensures consistent data collection, and transferability assesses if the study descriptions and findings are ample enough to draw parallels with another setting^{32, 33}.

We used a multitude of strategies to ensure the rigor and trustworthiness of the findings. Primarily, to enhance the credibility of the data, the principal investigator (JB) of the study was knowledgeable about current trends in opioid use and prescribing and experienced with conducting qualitative studies. The research team comprised expert

qualitative researchers, orthopaedic surgeons, an experienced orthopaedic research coordinator, experts in chronic pain management, and a research assistant. The team underwent iterative discussions to ensure conceptual ideas were explored and well-organized via peer debriefing meetings. Additionally, we deliberated preliminary findings/coding categories with experts in the field to increase trustworthiness. Furthermore, we used triangulation to enhance the trustworthiness of our findings³⁴. We used member checking, where we asked participants to check the completeness of the summary of findings based on their responses at the end of the interview³⁵. In addition to the interview transcripts, the interviewers kept a field diary and took notes throughout the interviews. These were complemented with a reflective journal to interpret and make explicit the perspectives that the researchers brought to the research process, to ensure interpretive authority (**Appendix 3-B**)³⁶. We also created an audit trail of the full analytical process to record all the steps from data collection to the finalized interpretation²³.

RESULTS

Characteristics of participants

Out of the 27 participants who we interviewed, the majority were male (n = 21, 78%) (**Table 7**). The length of surgical practice varied in each country, ranging from less than one year to 20 years in Canada, two to 20 years in the Netherlands, and 11 to 28 years in Japan. Sixty-four percent of the surgeons in Canada, 78% in the Netherlands, and 50% in Japan practiced in academic settings. Half of the participants in Japan reported practicing in both academic and community settings. The numbers of TKA and THA procedures

performed annually by surgeons in Canada and the Netherlands were relatively higher compared to those in Japan (surgeons' estimate of 105-600 in Canada, 50-600 in the Netherlands, and 24-220 in Japan). In-hospital stay post-operation was reported as 0-3 days for both TKA and THA in Canada and the Netherlands, while it was relatively longer in Japan (10-30 days). Surgeons in Canada reported that 100% (IQR 0) of their patients were prescribed opioids, similar to 100% (IQR 90% - 100%) in the Netherlands. In contrast, surgeons in Japan reported that 65% (IQR 8.6% to 100%) received opioid prescriptions. In addition, the orthopaedic surgeons from Canada and the Netherlands indicated a wider usage of opioids, such as morphine, oxycodone, and hydromorphone, alongside non-steroidal anti-inflammatory drugs (NSAIDs) and paracetamol/acetaminophen, as compared to their Japanese counterparts, who predominantly prescribed NSAIDs and Tramadol (**Table S3.1**).

We grouped data on barriers and facilitators into six categories (**Tables S3.2 to S3.7, Figures S3.1 and S3.2**): 1) surgeons' prescribing practices, 2) perceptions on patient factors, 3) collaborative patient care, 4) policies, guidelines, and regulations on opioid prescribing, 5) opioid risk mitigation via continuing surgeon education, and 6) personal perceptions and beliefs on opioid prescribing.

Table 7 Demographic and practice characteristics of orthopaedic surgeons in the three countries

	Canada (N = 11)	The Netherlands (N = 9)	Japan (N = 7)
Male	9 (82)	6 (67)	6 (86)
Years of practise	<1 to 20	2 to 20	11 to 28
Practise setting^b			
Academic	7 (64)	7 (78)	3 (50)
Community	3 (27)	2 (22)	0
Both	1 (9)	0	3 (50)
Arthroplasty Procedures Performed Annually	105 to 600	50 to 600	24 to 220
TKA	70 to 300	30 to 300	0 to 150
THA	15 to 300	0 to 300	0 to 150
Average LOS (days)			
TKA	0 to 3	0 to 3	10 to 30
THA	0 to 3	0 to 3	10 to 30
% of Patients Prescribed Opioids^a	100 (0)	100 (90, 100)	65 (8.6, 100)

^aMedian (IQR); ^bN=6 for Japan (one participant did not answer the question); TKA, Total Knee Arthroplasty; THA, Total Hip Arthroplasty; LOS, Length of Stay

Surgeons' prescribing practises

We identified several facilitators emerging from surgeons' reported prescribing practices for pain management (**Table S3.2, Figures S3.1 and S3.2**). Surgeons in all three countries considered patients' unique needs, characteristics, and medical history when prescribing opioids or deciding to refill. Likewise, all surgeons reported using multimodal analgesia for pain management, consisting of opioid analgesics, NSAIDs, acetaminophen/paracetamol, etc. Canadian and Dutch surgeons stated that they had decreased the quantity and duration of opioid prescriptions over their years of practice, with many currently prescribing opioids *pro re nata* (PRN or use-as-needed). Moreover, Canadian and Dutch surgeons shared concerns about the adverse effects of opioids, specifically addiction, and misuse. For example, one surgeon stated:

“I think the risk of addictive potential outweighs the benefit of you not having the amount of pain that you have.” – Participant 1855, CA

Conversely, Japanese surgeons expressed apprehension about additional side effects, such as falls, sedation, nausea, constipation, and hepatic dysfunction, in addition to addiction. All Canadian surgeons unanimously endorsed using non-pharmacological strategies for pain management (e.g., ice, compression, physical therapy, etc.). However, although most employed non-pharmacological strategies, some Japanese and Dutch surgeons said that they did not. Most Japanese surgeons held a different view compared to Canadian and Dutch surgeons, as they believed that opioids were not necessary for postoperative pain management, and preferred to use non-opioid alternatives such as NSAIDs or paracetamol. One Japanese surgeon mentioned:

“I recommend that don't use opioids, we can manage without opioids for the postoperative patient. That is my message.” – Participant 2817, JAP

However, some Japanese surgeons prescribed tramadol to all of their patients. Meanwhile, in the Netherlands, all surgeons used a standard institutional protocol for postoperative/discharge pain management, which reduced variations in prescribing practices among colleagues.

Surgeons in all three countries reported encountering several barriers and challenges. They expressed concerns about the side effects of non-opioid analgesics such as NSAIDs or acetaminophen:

“I think it's based on side effects or at least a discussion about side effects, because there's always a lot of literature about side effects of NSAIDs...So at the moment, also in the General Practitioners office, there's a change in NSAIDs policy.” – Participant 2288, NL

Moreover, Dutch and Canadian surgeons highlighted the tension they faced between the need to relieve patients' pain and preserve their mobility while minimizing the risks of opioid use. For example, one surgeon described:

“Finding the right balance between pain management, pain relief, on the one side and on the other side, trying to avoid addiction, trying to avoid side effects. And. Yeah, I think those are two most important things. So, it's always a struggle because on the one hand you want to have your patients to mobilize early and quickly because that will provide them a better outcome on a functional level. On the other hand, you cannot achieve that without any any pain medication. But you don't want to give them too much pain medication, and you don't want all the negative side effects of the pain medication. So, it's finding the optimum in between them.” – Participant 1258, NL

These surgeons also noted that their busy schedules hindered their ability to monitor patients' opioid use and conduct thorough consultations frequently. Although Dutch surgeons followed standard institutional protocols for postoperative and discharge prescribing, some surgeons were unfamiliar with the specific details of the protocol as the

anesthesiologists were primarily responsible for immediate postoperative prescribing. On the other hand, most Canadian and Japanese orthopaedic surgeons lacked a standard institutional protocol, leading to increased inter-surgeon variability in opioid prescribing. Many Canadian surgeons perceived that senior orthopaedic surgeons exhibited resistance to reducing opioids and had outdated prescribing practices, with one surgeon stating that:

“I have guy one year in and I have a guy, that guy there 25, 30 years. So it's, it's we're creatures of habit. It's it's not an easy thing to break sort of what we've been doing for many, many years. So newer medications or at least medications we use more commonly or probably more like more commonly like to date more likely be used by a newer surgeon, than somebody that's been practicing for 20 to 25 to 30 years.” – Participant 2116, CA

They also pointed out that, ultimately, differences in individual surgeons' preferences, experiences, and training may explain variations in prescribing practices.

Patient factors

All Dutch and Canadian orthopaedic surgeons reported that either they or a member of the care team provided patients with pre- and postoperative education about pain expectations, medications, and potential side effects (**Table S3.3, Figures S3.1 and S3.2**). Moreover, Dutch surgeons also offered education about the pain management ladder, prioritizing non-opioid analgesics, and strategies for tapering opioid use. However, some Japanese surgeons did not provide patient education as they believed it was only necessary when prescribing strong opioids. Orthopaedic surgeons in Japan noted that cultural factors led to resistance to opioid use among Japanese patients, who preferred non-opioid pain management options. For example, one surgeon mentioned:

“My patient don't want to prescribe opioid, because Japanese are resistant to opioids...” – Participant 2756, JAP

These surgeons further observed that patients were satisfied with pain management using weaker opioids or non-opioid analgesia, which resulted in no leftover medications.

Conversely, Canadian and Dutch surgeons shared concerns about the potential for patients to divert unused opioids for misuse. Only a quarter of surgeons reported providing instructions to patients about how to properly dispose of unused opioids, such as returning them to the pharmacy. Surgeons in both countries also expressed concerns about patient dissatisfaction with reduced quantity/dosage of opioids and the use of non-opioid pain management modalities. Moreover, the surgeons noted that patients frequently harbored unrealistic expectations of being entirely pain-free following surgery and that many patients had a low tolerance for pain, with individual variations in pain perception, making it challenging to decrease opioid prescribing universally. Specifically, one surgeon in Canada stated:

“I think I think that for a while we had this concept of like pain free surgery that somehow, we were going to magically have people have big operations and not have any hint of pain. Well, the only way to do that is to stay unconscious until you're healed, right?” – Participant 1205, CA **Collaborative care**

A portion of the discussions with orthopedic surgeons from Canada and the Netherlands centered around collaborations with other healthcare providers, pain clinics, and pharmaceutical departments to enhance patient care and education, to receive education on opioid prescribing, and to develop a standardized pain management protocol within their institutions (**Table S3.4, Figures S3.1 and S3.2**). These collaborations also aimed to provide optimal care for patients struggling with substance use disorders. Japanese and

Dutch surgeons described that the anesthesiologists were primarily responsible for decisions regarding patients' prescriptions and, at times, surgeon and patient education.

Although interprofessional collaboration is central to optimizing patient care and satisfaction, orthopedic surgeons in all three countries shared apprehensions about patients obtaining opioid refills from "invisible sources." This refers to situations where patients may acquire refills from other healthcare providers without the surgeon's knowledge or authorization. For example:

“So the tricky part is that it's not always my decision. So I would love it to be something that I'm always involved in. But patients sometimes go to their family doctors and then go to other prescribers, right? And we do have some information that, you know, a lot of the prescriptions within the first sort of 6 weeks after surgery are by others. And they don't necessarily inform us when they're prescribing a patient more pain medication, right.” – Participant 1205, CA

Also, Canadian surgeons expressed challenges with referring patients to pain clinics for more specialized care, as they often had long wait times. In contrast, many Japanese surgeons described that their institution lacked a specialized pain management team making it challenging for them to refer patients with more unique needs to professionals who are more experienced in managing pain. Furthermore, Dutch surgeons described inconsistencies in opioid prescribing patterns and attitudes among healthcare professionals within a patient's care team, especially if providers other than the surgeon were involved in prescribing.

Policies, guidelines, and regulations on opioid prescribing

In Canada, surgeons identified provincial campaigns on opioid reduction and institutional regulations and monitoring as facilitators (**Table S3.5, Figure S3.1**). Notably, some

Canadian surgeons perceived that there is reluctance in the orthopaedic community to prescribe opioids due to fear of litigation or license suspension, stating:

“I think they're driven, mainly by the opioid crisis in the States. So, like surgeons down there can go to prison for example if they're found to be like overprescribing but that may not be intentional so there's a reluctance to prescribe in today's climate.” – Participant 1855, CA

Moreover, some Japanese surgeons utilized chronic pain guidelines and the Japanese Orthopaedic Association guidelines to inform their opioid prescribing practices. They highlighted that strict regulations on using more potent opioids significantly restricted their ability to prescribe them. Moreover, some surgeons also identified that their national insurance system constrained the type of opioids prescribed for chronic non-cancer pain, which may be perceived as a facilitator. In both Japan and the Netherlands, the hospitals' pharmaceutical departments monitored opioid prescriptions and set internal restrictions on the amount that could be prescribed, which facilitated opioid reduction. Dutch surgeons also described institutional regulations and protocols that guided opioid prescribing. However, many surgeons were unaware of external policies and guidelines. Likewise, most Canadian and Japanese surgeons lacked of knowledge about current policies and guidelines for opioid prescribing (**Figure S3.2**). Some Canadian surgeons believed that current policies and guidelines on opioid pain management were outdated. Some also felt that the strict opioid prescribing policies and restrictions placed pressure on them and hindered their ability to provide individualized care, particularly for patients experiencing severe pain requiring a higher dose or quantity of opioids:

“I think one of the challenges we run into is that the hospital, you know has developed these policies about how many opioids, you should prescribe to people and everything and their residents get a lot of pressure in our electronic system about how many tablets can be on a prescription and everything. And whilst that's

very good. I think there there are some things that are just very painful and that require more than, you know 20 tabs of an opioid like if you have your knee replaced, odds are you're going to need more than 20 tablets or something. So I think that's a struggle because I think, again, there are some patients who need more than what the hospital policies are designed for.” – Participant 1983, CA

Opioid risk mitigation via continuing surgeon education

Orthopaedic surgeons from all three countries discussed their experiences and perspectives on continuing education regarding safer opioid prescribing (**Table S3.6, Figures S3.1 and S3.2**). Some Canadian and Dutch orthopedic surgeons mentioned that they were actively involved in opioid-related research and were members of arthroplasty or orthopedic groups and societies. Others also recalled receiving institutional/departmental training on pain management and opioid prescribing (i.e. through modules, meetings, rounds, conferences). Conversely, while some Japanese surgeons' institutions provided additional training and guidance on opioid prescribing, many surgeons reported completing external e-learning modules for every type of opioid that they prescribed. They also noted receiving education on specific medications from pharmaceutical companies.

Thirty-six percent (4 of 11) of Canadian, 50% (3 of 6) of Japanese, and 55% (5 of 9) of Dutch surgeons stated that they had not received any education after their medical training on opioid prescribing. While some of these surgeons did not see the need for further education, others recognized its importance. For example, Canadian surgeons emphasized the need for more education on identifying abuse, pain management for vulnerable populations, dosing, non-opioid alternatives, and prescribing trends, with a preference for online and short educational sessions. Likewise, Dutch surgeons identified a lack of formal education on available multimodal pain management protocols, relevant literature updates,

novel products, and emerging non-opioid alternatives. In contrast, Japanese surgeons highlighted the need for education on Substance Use Disorder (SUD) risk factors and postoperative pain management strategies specifically for this population.

Personal perceptions and beliefs on opioid prescribing

Orthopaedic surgeons from Canada, the Netherlands, and Japan had varying perceptions of opioid prescribing, but some similarities were observed (**Table S3.7, Figure S3.1**). All three groups acknowledged that TKA is more painful than THA. Many Canadian and Dutch surgeons believe that opioids are necessary for improving patients' sleep and mobility, and subsequently, cannot be eliminated from post-THA/TKA pain management protocols:

“And, yeah, I mean it is an arthroplasty procedure, it does hurt, to some degree, so I don't think that there's you know completely eliminating narcotics is necessary either we just have to be very cognizant of dependence and abuse, and be very restrictive on how we, we do that.” – Participant 2373, CA

On the other hand, some Canadian surgeons thought that opioids are not effective in managing pain and expressed regret for over-prescribing in the past. Almost all orthopaedic surgeons in Japan considered Tramadol less addictive, but some desired more potent and longer-duration opioids. One surgeon stated:

“There is still. Still, there is a patient who suffered, will suffer pain. So we want to use more strong painkiller. As mentioned before, the amount of the opioid is very, the amount of the opioid we can use in Japan is very restricted, so we can use very small amount. So we want to use more, but we cannot.” – Participant 2297, JAP
Many surgeons in Japan and the Netherlands exhibited knowledge gaps and uncertainty regarding SUD. Moreover, Japanese surgeons believed that SUD is more prevalent in North America and Europe, while Dutch surgeons perceived a more severe opioid crisis in North America.

DISCUSSION

To better understand the drivers of practice variations and the barriers and facilitators to opioid reduction, this study compared the perceptions held by orthopaedic surgeons in Canada, Japan, and the Netherlands regarding postoperative opioid prescribing. The perceptions gleaned from this study concerned surgeons' prescribing practices, patient-related factors, collaborative care, policies and guidelines on opioid prescribing, continuing education, and personal beliefs shaping practice. Although there is increasing recognition of the contentious nature of using opioids for pain relief post-operatively, our findings indicate that a majority of participants in Canada and the Netherlands still prescribe opioids to 99% to 100% of their surgical patients. The use of a multimodal analgesic approach was indicated in the three countries. However, we noted significant discrepancies in the choice of prescribed opioid medications, especially between Canada and Japan, which relied more on Tramadol. Consistent with other literature, our findings suggest differences in prescribing practices between Canadian, Dutch, and Japanese orthopaedic surgeons emanate from individual, patient, and system-level disparities³⁷⁻⁴⁰.

Orthopaedic surgeons in this study discussed their current prescribing practices and barriers hindering efforts to implement opioid reduction strategies. Self-reported opioid prescribing rates at discharge for knee and hip arthroplasty patients were highest among Canadian and lowest among Japanese surgeons. This trend is consistent with other literature suggesting higher opioid prescribing rates for surgical populations in North America, followed by Western Europe, and lastly, Japan^{11, 37, 40}. Orthopaedic surgeons in Japan held

the notion that opioids are superfluous for managing post-operative pain, which consequently led to comparatively lower opioid prescribing practices, as opposed to their counterparts in Canada and the Netherlands, who believed that opioids are indispensable and cannot be completely eliminated from postoperative pain management protocols. A survey comparing opioid prescribing patterns among 164 orthopaedic surgeons in the USA and Japan also reported that more participants in the USA strongly believed that opioids are necessary for outpatient post-surgical pain control compared to those in Japan (22.7% in the USA vs. 2.7% in Japan).

All participating surgeons were cognizant of the burgeoning global opioid crisis. Consequently, Dutch and Canadian surgeons narrated a decrease in opioid prescribing, with some surgeons altering the primary type of prescribed opioid over their years of practice. Due to the already low levels of opioid prescribing for postoperative pain management in Japan, the surgeons did not recollect substantial alterations in their opioid prescribing practices throughout their careers. All participants discussed the use of multimodal strategies which facilitated opioid reduction over the years. Multimodal analgesia regimens are considered a crucial component of Enhanced Recovery After Surgery Programs, and can reduce postoperative opioid consumption and related adverse effects while improving pain outcomes among knee and hip arthroplasty patients⁴¹⁻⁴⁴. Moreover, all included surgeons in the Netherlands utilized an evidence-based, institutional standard pain protocol and an analgesic ladder, recommending non-opioid therapies as the first line of treatment, which was infrequent in Canada and Japan. Several studies have reported that the implementation of standard institutional protocols restricting opioid use has resulted in

lower mean consumption of opioids, underscoring the need for Canadian institutions to establish standardized protocols⁴⁵⁻⁴⁷. A review of the literature on the applicability of the World Health Organization's (WHO) analgesic ladder to manage chronic non-cancer pain revealed the need for modification by incorporating four steps, with integrative therapies being adopted at each step to mitigate opioid use, reserving the use of more potent opioids for the final stage⁴⁸.

Notably, in Japan, patients are hospitalized for several weeks following most elective surgeries, in stark contrast to the Canadian or Dutch healthcare systems, which are rapidly transitioning towards outpatient care settings. During hospitalization, Japanese patients receive intensive rehabilitation and pain management while being closely monitored by medical and nursing staff, resulting in their exposure to opioid medication being subject to strict surveillance⁴⁰. The challenges surgeons in Canada and the Netherlands identified with finding the time to monitor patients' opioid use and for lengthy consultations highlight a need for improved support and resources for orthopaedic surgeons. This could include providing additional time and resources for patient monitoring and consultations and implementing systems to facilitate communication and collaboration between healthcare providers and other professionals. Additionally, the implementation of telemedicine solutions could be explored to increase access to care and facilitate remote monitoring of patients' opioid use⁴⁹.

As a facilitator, both Dutch and Canadian participants reported providing patient education regarding acceptable expectations for pain control, benefits, and risks of opioids, and standard instructions on medication usage. Dutch surgeons additionally provided

information on the analgesic ladder. However, both populations of surgeons seldom instructed patients on how to dispose any unused opioid medications safely. Consistent provision of instructions to patients regarding safe storage and disposal methods may serve as a preventive measure against the diversion of unused opioids for potential abuse or misuse^{50, 51}. Japanese surgeons perceived that instructions on leftover medications were unnecessary as they rarely prescribed opioids at discharge. However, an intriguing finding emerges from a recent cross-sectional study involving 387 Japanese patients with chronic non-cancer pain, which revealed high rates of opioid misuse and abuse, with reported figures of 38% (CI 37.9% to 44.1%) and 17% (CI 12.6% to 22.1%), respectively⁶. This underscores the continued importance of imparting crucial information to patients regarding the risks associated with opioids, exploring alternative treatment options, and providing guidance on safe handling and proper disposal methods. Surgeons in Japan highlighted a social and cultural resistance among patients to using opioids and, thus a preference for non-opioid analgesia. This inclination may stem concomitantly from the perception that chronic opioid use may be a criminal offense and cultural mores regarding self-attention, discouraging individuals from voicing pain-related concerns⁹. Despite this, many Japanese surgeons continue to prescribe Tramadol. Interestingly, Tramadol depends primarily on metabolites to produce its pain-relieving effect. However, this effect may vary, resulting in different risk levels among individuals due to genetic variations. While some surgeons may consider Tramadol a relatively safer pain reliever, it still has the potential for adverse effects¹¹. Additionally, Canadian and Dutch surgeons expressed that opioid prescribing was influenced by patient expectations and satisfaction, noting that patients

generally prefer opioid medications over alternative options. This tendency could be attributed, at least in part, to patients' expectations of being pain-free after surgery. Nonetheless, these surgeons also reported providing preoperative counseling to patients regarding reasonable expectations for pain management.

Surgeons in this study were involved in interprofessional collaborations to optimize patient care through education and pain management and support patients with co-morbid conditions or substance use disorders. However, they reported challenges with patients procuring opioid refills from other healthcare providers without their knowledge. Notably, up to 20% of patients engage in “doctor shopping” for additional opioids after traumatic orthopaedic injuries⁵². Consequently, there is a necessity in orthopedic surgery to augment patient education regarding the perils of addiction and misuse. This could be accomplished through partnerships with community health and addiction services and by devising and implementing systems for disseminating patient information between healthcare providers and organizations. Although numerous Canadian participants reported referring their patients to pain management clinics for further care, they also noted significant delays before patients can receive the necessary treatment. In contrast, some surgeons in Japan reported the absence of specialized pain management teams within their institutions, emphasizing the need for such teams to assist them in providing care and education to patients with chronic pain requirements or with a history of SUD⁶. Moreover, many Dutch surgeons reported that, despite there being no variations in opioid prescribing between themselves and orthopaedic surgeons within their institutions due to adherence to a standard pain management protocol, they observed differences in prescribing and opioid

dispensing patterns among other members of their team, such as nurses, physician assistants, and residents. While interprofessional collaboration is a fundamental aspect of patient-centered care, divergent perceptions regarding opioid use among team members may result in unintended consequences. Consequently, patient care team members must receive comparable education on opioid prescribing, particularly concerning standard protocols, as do orthopaedic surgeons.

Surgeons from the Netherlands and Canada demonstrated an awareness of institutional regulations and restrictions on opioid prescribing. In Canada, some surgeons reported being aware of provincial initiatives aimed at reducing opioid consumption, while others expressed concerns that the fear of legal repercussions or the revocation of their medical license for over-prescribing opioids often resulted in a reluctance to prescribe these medications. The 2017 Canadian Guideline for Opioids for Chronic Non-Cancer Pain offers direction for physicians in Canada regarding the prescription of opioids, advocating for a more conservative approach⁵³. This guideline is complementary to the Safe Prescribing of Opioids and Sedatives practice standard by the College of Physicians and Surgeons of British Columbia⁵⁴. Similarly, in Ontario, several resources are available to orthopaedic surgeons, such as the Public Health Ontario Interactive Opioid Tool and the Health Quality Ontario MyPractice, which allows physicians to confidentially compare their opioid prescribing patterns with those of their peers^{55, 56}. However, despite the availability of these tools and practice guidelines and standards, many Canadian surgeons were unaware of their existence or considered them outdated. As such, there is a need for increased dissemination of information regarding existing guidelines, practice standards,

and relevant literature for all surgeons. Furthermore, there is also a need for evidence-based opioid prescribing guidelines for orthopaedic surgeons in the Netherlands⁵⁷.

Differences in opioid prescribing between Canada, the Netherlands, and Japan may also stem from variability in healthcare systems. Specifically, Japan has a national insurance system that strictly enforces the indications for each medication, as non-compliance would result in a lack of insurance coverage. For instance, the use of oxycodone is only covered by insurance for treating cancer pain and cannot be prescribed for other types of pain. Similarly, a combination of tramadol and acetaminophen is only covered for non-cancer pain and tooth extraction⁹. Additionally, physician prescribing for chronic non-cancer pain must fulfill several requirements: the physician must have completed e-learning modules for each specific opioid, the physician and patient must sign a contract prior to initiating opioid therapy, the patient must be taking non-opioid analgesics first, and the patient must undergo trial use of a challenge opioid to ensure effectiveness⁹. There is a need for evidence- or consensus-based recommendations on postoperative opioid prescribing for orthopedic surgical procedures, particularly for total knee and hip arthroplasty.

Although participants reported having received training on pain management and opioid prescribing through institutional or departmental programs, such as modules, meetings, rounds, or conferences, some surgeons indicated that they had not received any continuing education on the subject or considered it to be unnecessary. A systematic review evaluating institutional strategies to reduce opioid administration and consumption after orthopedic surgery found that provider education can increase awareness of responsible opioid prescribing practices and non-opioid treatment modalities, reducing opioid

prescribing⁵⁸. Canadian and Dutch Surgeons wanted increased education on strategies for identifying abuse, managing pain for vulnerable populations, dosing, non-opioid alternatives, and trends. However, Dutch and Japanese surgeons also preferred greater training in caring for patients with SUDs. Surgeons noted a preference for concise, online training modules/seminars occurring annually or semi-annually due to their demanding schedules.

Limitations

When interpreting the findings of this study, several limitations must be considered. Firstly, despite their potential involvement in opioid prescribing, orthopedic residents and trainees were not included in the sample. Their perceptions and ideas may differ from those of more experienced surgeons. However, we sought maximum variation in the number of practice years, which ranged from less than one year to 28 years among participants. Additionally, our study involved surgeons who volunteered to participate and thus, may have had a heightened interest or stronger perceptions regarding opioid use and prescribing. For example, some participants were involved in research pertaining to opioids. Nonetheless, understanding their perceptions is crucial for determining if their experiences influence their perceptions of opioid prescribing patterns. Also, there was considerably more male than female participants in our study, potentially reflecting the under-representation of women in orthopedic surgery in all three countries of interest²⁴. While we recruited orthopedic surgeons from various regions in the Netherlands and Japan, most Canadian surgeons who consented to participate were from Ontario or Eastern Canada. Given the variability in opioid consumption and prescribing among patients across provinces and

cities, our results may not be transferable to other settings or countries due to differences in population makeup and cultures. However, several of our findings correspond with and expand upon existing international literature. Moreover, our sample primarily consisted of surgeons practicing in academic settings, which may stem from inherent limitations in convenience and snowball sampling. Additionally, interviews were conducted in English, which may have created comprehension difficulties for some Japanese surgeons. However, we provided the option of a translator if necessary. Although there is a potential for social desirability bias in participants' responses, we endeavored to minimize this bias by obtaining feedback on our interview guide from field experts and orthopedic surgeons to ensure that there were no leading questions, by using indirect questioning, probing and clarifying participant responses, and providing assurance of confidentiality and anonymity prior to commencing the interviews⁵⁹.

CONCLUSIONS

This study elucidated orthopaedic surgeons' perceptions of their opioid prescribing practices, patient-related factors, collaborative care, policies and guidelines governing opioid prescription, continuing education, and personal perceptions influencing practice. Despite the growing recognition of the controversial nature of utilizing opioids for postoperative analgesia, our findings indicate that a majority of participants in Canada and the Netherlands continue to prescribe opioids to virtually all of their surgical patients. Our findings suggest that the variations in prescribing practices among Canadian, Dutch, and Japanese orthopedic surgeons originate from disparities at the individual, patient, and

system levels. We identified several barriers at each level, which can predominantly be addressed by improving patient and provider education, implementing standardized pain management protocols in institutions, enhancing communication between primary care and orthopedic surgeons, developing updated opioid prescribing guidelines and practice standards, particularly for knee and hip arthroplasty surgeons, and improving knowledge translation and dissemination efforts.

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APPENDICES AND SUPPLEMENTARY INFORMATION

Appendix 3-A Semi-structured interview guide

Demographics

1. What is your gender?
2. For how long have you been practicing as an orthopedic surgeon (in years)?
3. Do you work in an academic or community setting?
4. Approximately how many total knee arthroplasty procedures do you do in a year?
5. Approximately how many total hip arthroplasty procedures do you do in a year?
6. On average, approximately what percent of your total joint arthroplasty patients get opioid prescriptions from you or your team?
7. What is the typical length of stay for a patient after total hip arthroplasty in your setting?
 - 7.1. What is the typical length of stay for a patient having total knee arthroplasty?

Pain questions (red - do not necessarily have to ask if they do not prescribe opioids at all)

1. Please describe your practices for pain management (out of hospital or after discharge) for total joint arthroplasty patients.
 - 1.1. *If no mention of non-pharmacological alternatives* - Do you use non-pharmacological alternatives for pain management? If so, please describe. (i.e. ice, compression, physical therapy etc.)
 - 1.2. Do you have any patients with substance use disorder?
 - 1.2.1. *If yes* - Do you change your practice of pain management for these patients? If so, how?
2. Do you do direct anterior hip replacement surgeries?
 - 2.1. *If yes* – Do you change your pain management method for people with direct anterior hips compared to those with other approaches?
 - 2.2. If so, how?
3. **Have you made any changes to your opioid prescribing practices over the years? If so, how? and why?**
4. What challenges are orthopaedic surgeons facing right now in terms of prescribing opioids and managing post-operative pain, if any?
5. Do you or any of your team members (e.g. nurse, physician assistant, etc.) provide patients with education about post-operative pain management?
 - 5.1. *If yes* - Please describe the education you provide.
 - 5.1.1. When do you usually provide this education to patients (i.e. before or after surgery)?
 - 5.2. *If no* - Do you think that TJA patients should be informed or educated about their pain management? If so, when and how?
6. **What is the typical length or quantity and dose of opioids that you give to patients?**
7. **How do you decide the length of opioid prescriptions that you give to patients?**
 - 7.1. *If they have a standard prescription* – how did you determine or decide on this standard prescription length?

- 7.2.** Do you provide instructions to patients on how to manage unused opioid medications? If so, please describe.
- 8.** What do you do if the patient you prescribed opioids to still has pain after the prescription is done? (*probe* - do you change or extend the prescription?)
 - 8.1.** What percent of patients request refills for prescribed opioid medications?
 - 8.2.** When patients request a refill of opioids, how do you decide to refill or not?
- 9.** Have you received any continuing education related to opioid prescribing?
 - 9.1.** *If yes* - what continuing education have you received (i.e. seminars, courses, etc.)?
 - 9.2.** *If no* - Do you think that continuing education related to opioid prescribing would be helpful? Why?
 - 9.2.1.** *If yes* - Describe the education that would be most useful for you.
- 10.** Do you think that there are differences between you and other orthopedic surgeons in opioid prescribing for joint arthroplasty at your hospital?
 - 10.1.** *If yes* - why do you think some surgeons in your hospital prescribe more or fewer opioids than others?
 - 10.2.** Are there any policies and guidelines that you use to support or guide you in prescribing opioids?
- 11.** In general, do you think that opioids are appropriately prescribed for joint arthroplasty patients by surgeons in your hospital/institution?
 - 11.1.** *If no* - Why?
- 12.** Do you have any additional thoughts or comments about opioid prescribing for total joint arthroplasty procedures that we haven't yet discussed? Anything else that came to mind during the interview?

Appendix 3-B Positionality/reflexivity statements of the two interviewers (MP and PP, respectively)

MP

I identify as a South-Asian, Canadian, graduate student, and am able-bodied and cis-gendered (female). Considering my experiences and views, I find constructivism relevant as I believe that all truth is relative and socially constructed by individuals (i.e. subjective experiences of pain). Additionally, in light of my background in quantitative research, I believe that the findings of a study should be treated as though they will be applied in practice, and should not merely be theoretical (pragmatism). Accordingly, my choice of research design, as guided by my beliefs and values, would be a qualitative description approach. This is primarily because the idiosyncratic experiences of pain constitute multiple constructed realities. Furthermore, as a result of my experiences, I believe that reality is complex, contextual, constructed, and ultimately subjective. As I will be using a qualitative description approach, semi-structured, 1:1 interviews are the most optimal data sources.

Presently, I am a graduate student in the Health Research Methodology program, and am not a health care practitioner and do not have a professional background. Accordingly, while carrying out the data collection phase of the study, I perceive that the participants will provide me with broader, non-health-related content during the interviews as I do not have a professional role, and some participants may have inherent biases relating to my role as a student. Moreover, as I do not have a professional identity or title, my gender (female) and relatively young age (22 years) would be key variables that would interact with and influence the interview process. For example, it is plausible that communication during the interview may be more colloquial than it would be if the interviewer were a practicing professional, regarded as being at a higher social and professional status than me. Additionally, as I would be in a position of an “outsider” in terms of not being a practicing medical professional and not having first-hand experience with opioids, there will be some limitations in my ability to fully understand the formal and informal aspects of opioid prescribing and certain situations. Subsequently, there may be a barrier to recognizing more subtle language use, associations, jargon, and cues. Although having second-hand experience with post-operative pain and opioids (due to my extensive observations of my grandparents who were reliant on opioids for their post-TKA pain) is not equivalent to being afflicted with pain or using opioids directly, I can approach the process of data collection and analysis with some knowledge about this subject. Likewise, I have done several projects pertaining to the opioid crisis and assessing the efficacy of specific non-opioid alternatives for pain. However, the risk of “blurring boundaries” between the interviewer and interviewee would be minimized as I would be coming from an “outsider” perspective. In spite of this, being partly “ignorant” of the phenomenon puts the respondent in an expert position, and this may, in turn, allow me to approach data collection and analysis from a novel viewpoint.

In light of my extensive background in pain research and related personal experiences, I may be biased and inclined to focus more on the positive perceptions of surgeons who recognize that there is an opioid crisis and their practise considers its

implications as they heed to all guidelines (potentially due to the social desirability bias). I believe that opioids are associated with numerous adverse events and surgeons should avoid using opioids when possible. Therefore, a constant deliberate effort will be necessitated to ensure that I am precisely documenting the complete narrative, and I must scrutinize how I filter the interviewee's responses through the lens of my experiences.

PP

I identify as a cis-gendered male, able-bodied Canadian undergraduate student. My experiences and views align with the constructivism paradigm as I believe that truth is relative to the individual. In terms of the study's results, I hold a pragmatistic view that the study's findings should be treated as though they will be applied in practice.

As an undergraduate student in the Health Science program, I am not a health care practitioner and do not have a professional background. Consequently, I presume that the participants may provide me with simplified content during the interviews as I do not have a professional role and am relatively young (19 years old) compared to the participants. Due to my lack of professional background in the medical profession, I may have some limitations in my ability to understand certain aspects of opioid prescribing. I may also have difficulty understanding subtle language use, associations, jargon, and cues.

I do not have any personal experience or formal education on the topic of Opioids. However, through past article readings, I have come across Canada's Opioid Crisis and the devastating effects opioids have on individuals, families, and communities across Canada. Therefore, I may be inclined to pay focus on surgeons who recognize that there is an opioid crisis. On the other hand, I recognize that I do not know the full extent of the benefits that Opioids offer in particular medical applications. From my perspective, while Opioids may offer many benefits, medical professionals should limit their opioid usage unless deemed necessary. Ultimately, I will need to inspect how I filter the interviewee's responses through the lens of my experiences and ensure that I am precisely documenting the complete narrative.

Table S3.1 Pain medications prescribed by orthopaedic surgeons in Canada, Japan, and the Netherlands

Country	Pain Medications Prescribed
Canada	Acetaminophen NSAIDs Celecoxib Morphine Oxycodone/paracetamol Oxycodone Hydromorphone Tramadol Pregabalin Gabapentin
Japan	NSAIDs (e.g. Oxaprozin, Ibuprofen, Diclofenac, etc.) Celecoxib Acetaminophen Tramadol Serotonin and norepinephrine reuptake inhibitors (SNRIs) Fentanyl Tramocet
Netherlands	NSAIDs (e.g. Diclofenac, Naproxen, etc.) Paracetamol Celecoxib Oxycodone Morphine Tramadol

NSAIDs = Nonsteroidal anti-inflammatory drugs

Table S3.2 Facilitators and barriers influencing surgeons’ prescribing practises

	Canada	Japan	The Netherlands
Facilitators	<ul style="list-style-type: none"> • Decreased opioids quantity and length over years of practise • Considers patients’ individual needs, characteristics, and medical history when prescribing or refilling • Use of multimodal strategies for pain control • Non-opioid analgesia and non-pharmacological strategies are always used • PRN (use as needed) • Wary of the side-effects of opioids (particularly addiction and misuse) 	<ul style="list-style-type: none"> • Belief that opioids are unnecessary for managing post-operative pain (i.e. rarely prescribed post-operatively and post-discharge) • Heavy reliance on NSAIDs or acetaminophen • Ladder for pain management (non-opioid analgesia first, opioids as a last resort) • Non-pharmacological strategies are often used • Considers patients’ individual needs, characteristics, and medical history when prescribing or refilling • Regular monitoring of patients’ pain levels • Use of multimodal strategies for pain control • Wary of the side-effects of opioids (addiction, falls, sedation, nausea, constipation, hepatic dysfunction) 	<ul style="list-style-type: none"> • Decreased opioids quantity and length over years of practise • Standard institutional post-operative/discharge pain management is followed and revised regularly • Standard perioperative protocol decreases post-discharge opioid use • Considers patients’ individual needs, characteristics, and medical history when prescribing or refilling • Use of multimodal strategies for pain control • Non-pharmacological strategies are often used • Ladder for pain management (non-opioid analgesia first, opioids as a last resort) • PRN (use as needed) • Wary of the side-effects of opioids (particularly addiction and misuse) • Almost no perceived variation in opioid prescribing among in-hospital colleagues • Pharmacy instructs patients to return unused opioids
Barriers	<ul style="list-style-type: none"> • Concerns with side-effects of non-opioid analgesics (i.e. NSAIDs, acetaminophen) • Balancing patients’ needs for pain relief and mobility, and risks of opioids (tension from competing pressures) • Lack of effective alternative strategies for managing post-operative pain • Lack of institutional standard protocols for opioid prescribing • Busy schedule and lack of time to monitor patients’ use or for long consultations • Outdated prescribing practises and resistance to opioid reduction among senior orthopaedic surgeons • Differences in individual surgeons’ preferences, experiences, and training may drive variation in prescribing • No instructions given to patients on what to do with unused opioids 	<ul style="list-style-type: none"> • Concerns with side-effects of non-opioid analgesics (i.e. NSAIDs, acetaminophen) • Use of opioids pre-operatively due to long wait times for surgery • Lack of an institutional standard protocol for managing pain post-operatively and prescribing opioids 	<ul style="list-style-type: none"> • Concerns with side-effects of non-opioid analgesics (i.e. NSAIDs, paracetamol) • Balancing patients’ needs for pain relief and mobility, and risks of opioids (tension from competing pressures) • Busy schedule and lack of time to monitor patients’ use or for long consultations • Unfamiliar with the specific details of the institutional standard pain management protocol, as the anesthesiologist is largely responsible for immediate post-op prescribing

Table S3.3 Facilitators and barriers related to patient factors/perspectives

	Canada	Japan	The Netherlands
Facilitators	<ul style="list-style-type: none"> Provides pre-operative and post-operative education to patients about their pain expectations, side-effects, medications 	<ul style="list-style-type: none"> Cultural resistance to opioid use among Japanese patients (preference for non-opioid pain management options) Patient satisfaction with pain management using weak opioids or non-opioid analgesia No unused opioids leftover 	<ul style="list-style-type: none"> Provides pre-operative and post-operative education to patients about their pain expectations, side-effects, medications, pain management ladder, opioid tapering
Barriers	<ul style="list-style-type: none"> Concerns with patients': <ul style="list-style-type: none"> Dissatisfaction with less quantity/dosing of opioids Preference for opioids rather than alternatives Expectation of being pain-free after surgery Tolerance to pain Access to non-pharmacological or over-the-counter prescriptions (financial barriers) Patients may not return unused opioids and divert them for misuse 	<ul style="list-style-type: none"> Many patients do not receive education about their post-operative pain Perception that patient education about pain management is unnecessary or only required when prescribing strong opioids 	<ul style="list-style-type: none"> Patients may not return unused opioids and divert them for misuse Concerns with patients': <ul style="list-style-type: none"> Dissatisfaction with less quantity/dosing of opioids Preference for opioids rather than alternatives Expectation of being pain-free after surgery Perceptions of pain Patients concerned with side-effects of non-opioid analgesics (i.e. NSAIDs)

Table S3.4 Facilitators and barriers in providing collaborative patient care

	Canada	Japan	The Netherlands
Facilitators	<ul style="list-style-type: none"> Collaboration with other healthcare providers, pharmacy, and pain clinics on: <ul style="list-style-type: none"> Patient education Surgeon education Patients' pain management Caring for SUD patients Development of a standard pain management protocol 	<ul style="list-style-type: none"> Collaboration with anesthesiologists in decisions regarding patients' prescriptions, and surgeon and patient education 	<ul style="list-style-type: none"> Collaboration with other healthcare providers, pharmacy, and pain clinics on: <ul style="list-style-type: none"> Patient education Surgeon education Patients' pain management Caring for SUD patients Development of a standard pain management protocol
Barriers	<ul style="list-style-type: none"> Long wait times for pain clinic Invisible sources of opioids (concerns with patients receiving refills from other HCPs) 	<ul style="list-style-type: none"> Lack of a specialized pain management team/clinics Invisible sources of opioids (concerns with patients receiving refills from other HCPs) 	<ul style="list-style-type: none"> Invisible sources of opioids (concerns with patients receiving refills from other HCPs) Variability in the prescribing patterns of other HCPs on the care team

Table S3.5 Facilitators and barriers related to policies, guidelines, and regulations on opioid prescribing

	Canada	Japan	The Netherlands
Facilitators	<ul style="list-style-type: none"> • Provincial campaigns to decrease opioid prescribing • Institutional regulations and monitoring • Reluctance to prescribe opioids due to fear of litigation or licence suspension 	<ul style="list-style-type: none"> • Anesthesiologists have guidelines on opioid use • Existence of chronic pain guidelines and Japanese Orthopaedic Association Guidelines • Strict regulations on using strong opioids (e.g. morphine, oxycodone, etc.) • Hospital’s pharmaceutical department monitors opioid prescriptions • Some strong opioids are not covered by Japanese health insurance systems for non-cancer pain (e.g. Oxycodone) 	<ul style="list-style-type: none"> • Hospital’s pharmaceutical department monitors opioid prescriptions • Institutional regulations and monitoring
Barriers	<ul style="list-style-type: none"> • Outdated policies and guidelines • Many surgeons unaware of policies and guidelines for opioid prescribing • Pressure on surgeons to adhere to strict opioid prescription policies may hinder individualized care (e.g. for patients with severe levels of pain) 	<ul style="list-style-type: none"> • Many surgeons unaware of policies and guidelines for opioid prescribing 	<ul style="list-style-type: none"> • Many surgeons unaware of policies and guidelines for opioid prescribing

Table S3.6 Barriers and facilitators on opioid risk mitigation via surgeon education

	Canada	Japan	The Netherlands
Facilitators	<ul style="list-style-type: none"> • Involvement in opioid-related research and/or groups/societies • Institutional/departmental training on pain management and opioid prescribing (modules, meetings, rounds, conferences) 	<ul style="list-style-type: none"> • E-learning modules must be completed for each specific opioid surgeon prescribes • Pharmaceutical company provides education to surgeons (e.g. via brochures) • Institutional/departmental training and seminars 	<ul style="list-style-type: none"> • Involvement in opioid-related research and/or groups/societies • Institutional/departmental training on pain management and opioid prescribing (modules, meetings, conferences)
Barriers	<ul style="list-style-type: none"> • Insufficient surgeon training on strategies for identifying abuse, managing pain for vulnerable populations, dosing, non-opioid alternatives, and trends • Busy schedules of surgeons may decrease attendance to traditional, in-person educational sessions • Some surgeons have not received any continuing education/training on opioid prescribing, and/or perceive it as unnecessary 	<ul style="list-style-type: none"> • Many surgeons have not received any formal continuing education on prescribing opioids • Insufficient education on SUD (e.g. risk factors, management, etc.) 	<ul style="list-style-type: none"> • Insufficient surgeon training on multimodal strategies, updates, novel products, non-opioid alternatives • Some surgeons have not received any continuing education/training on opioid prescribing, and/or perceive it as unnecessary

Table S3.7 Surgeons’ personal perceptions and beliefs on opioid prescribing

	Canada	Japan	The Netherlands
Perceptions/beliefs on opioid prescribing	<ul style="list-style-type: none"> • Opioids are not effective in managing post-operative pain • Differences in the addiction potentials of opioids • Not possible to completely eliminate opioids in managing post-arthroplasty pain • Feeling of regret for over-prescribing • TKA is more painful than THA and requires more opioids • Opioids are necessary for improving patients’ sleep and mobility 	<ul style="list-style-type: none"> • Tramadol is not as addictive as other opioids • TKA is more painful than THA • Knowledge gaps and uncertainty surrounding SUD • Need for stronger and longer durations of opioids • Direct anterior approach is less painful than posterior approach • North American and European surgeons encounter more SUD concerns 	<ul style="list-style-type: none"> • Differences in post-op pain levels between private/community and academic hospitals • Differences in the addiction potentials of opioids • Knowledge gaps and uncertainty surrounding SUD • America has more serious problems with the opioid crisis • Not possible to completely eliminate opioids in managing post-arthroplasty pain • TKA is more painful than THA and requires more opioids • Opioids are necessary for improving patients’ sleep and mobility

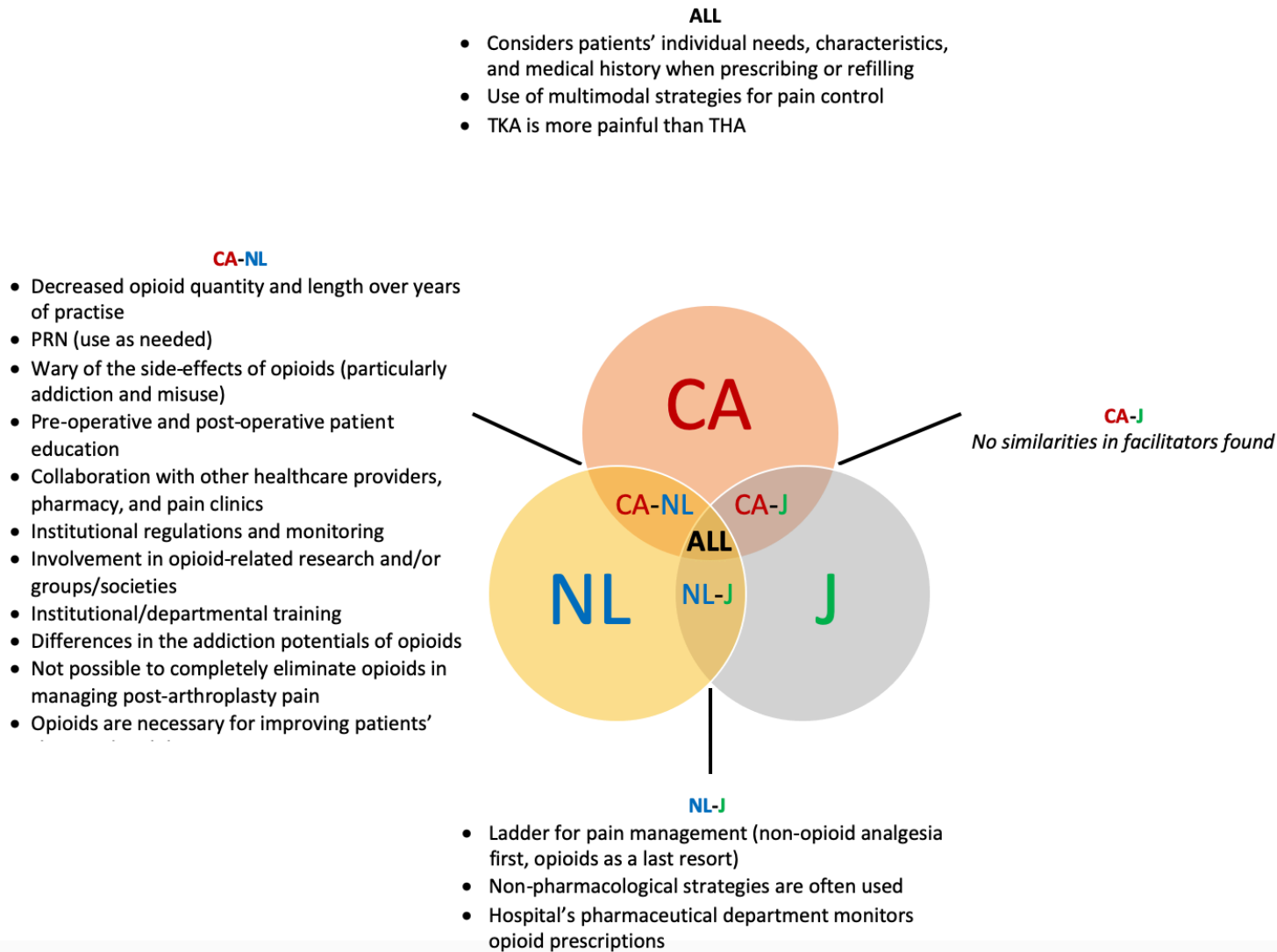


Figure S3.1 Comparison of factors perceived by surgeons as facilitating opioid prescribing in Canada, Japan, and the Netherlands

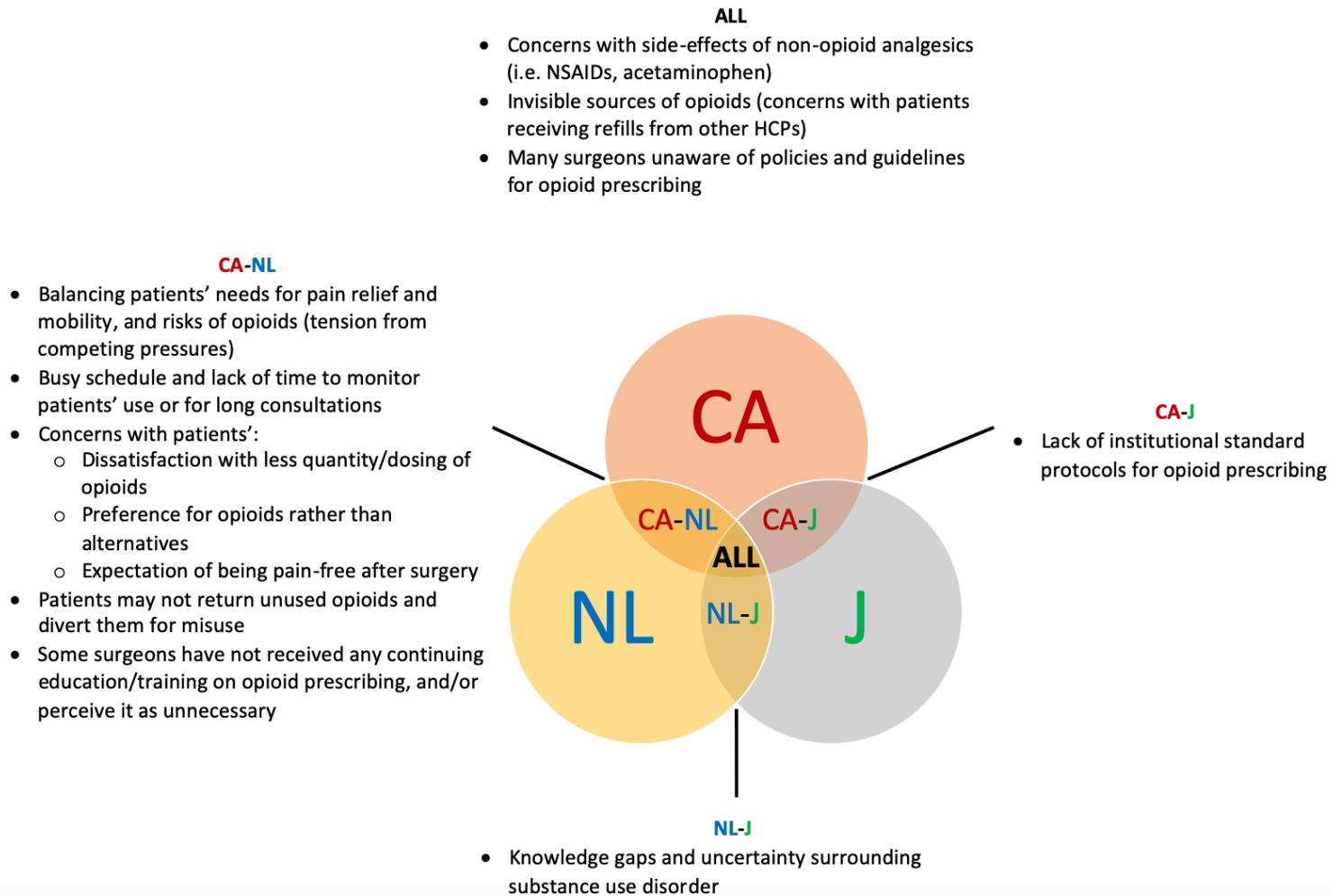


Figure S3.2 Comparison of factors perceived by surgeons as hindering opioid prescribing in Canada, Japan, and the Netherlands

Chapter 4: Discussion and conclusions

KEY FINDINGS OF THIS THESIS

Chapter 1: Addressing the opioid epidemic in orthopaedic surgery

The increase in the incidence of osteoarthritis is paralleled by a surge in the number of TKA and THA procedures performed, with pain being a common postoperative outcome. Opioids are traditionally used to manage pain despite the potential for adverse effects, including addiction, nausea, and overdose. The increase in morbidity and mortality associated with prescription and non-prescription opioid use has resulted in an opioid crisis, well-documented by past literature. The opioid crisis is one of the most profound public health challenges. Since the COVID-19 pandemic, it has been exacerbated at an alarming rate and has become a pressing concern in regard to health policy, healthcare guidelines, and management. Considering that orthopaedic surgeons are one of the highest opioid prescribers, there has been a recent trend towards prioritizing multimodal pain management approaches to reduce or eliminate the use of opioids. These programs comprise of a multitude of pharmacological options, non-pharmacological modalities, and patient education. Additionally, as pain is an idiosyncratic experience compounded by individual and surgical factors, better understanding patients' perceptions may provide valuable insights into their preferences, concerns, and willingness to explore alternative pain management approaches. This information can inform the development of patient-centered interventions and educational programs tailored to individual needs and expectations. Likewise, discerning orthopaedic surgeons' beliefs, knowledge, and attitudes toward opioid prescribing may aid in identifying latent facilitators and barriers to opioid reduction. A comprehensive understanding of both patient and surgeon perspectives may enable the

development of targeted interventions, guidelines, and educational programs promoting safer, more effective, patient-centered pain management practices.

Chapter 2: Patient perceptions towards reduction or avoidance of opioids following knee and hip replacement surgery: A cross-sectional survey

To our knowledge, this is the first cross-sectional study that specifically investigates the perceptions of patients who had undergone or were scheduled for TKA or THA on opioid use and reduction. Our findings demonstrated that patients' receptivity to opioid-reduced and opioid-free postoperative care was associated with their perceptions of the safety and efficacy of opioids, compared to other non-opioid alternatives, and opioid use at the time of participation. Patients who expressed reluctance towards reducing or eliminating opioids after their surgery voiced concerns about the potential for experiencing intolerable pain. In contrast, individuals who demonstrated a willingness for reduced or opioid-free approaches had either encountered or expressed apprehension about the adverse effects of opioid usage. While most participants expressed concerns about addiction, the level of concern varied among individuals. Participants also exhibited a lack of knowledge regarding non-opioid modalities for pain management. Although this study was limited by a small sample size, primarily comprising TKA patients and females, an educational approach emphasizing the efficacy and safety of opioids and non-opioid alternatives, and addressing patients' psychological needs and pain expectations may dispel anxieties and rectify misunderstandings. Future studies may aim to assess potential differences in perceptions based on specific types of surgeries, comorbidities, prior opioid exposure, and risk factors.

Chapter 3: Perceptions on opioid prescribing after total joint arthroplasty among orthopedic surgeons practising in Canada, Japan, and the Netherlands: A qualitative description study

This is the first qualitative research study to explore and compare the perceptions of surgeons on opioid prescribing for TKA and THA in three countries that represent high (Canada), moderate (the Netherlands), and low (Japan) opioid prescribing practices. This study identified barriers and facilitators on surgeons' prescribing practices, patient-related factors, collaborative care, policies and guidelines on opioid prescribing, continuing education, and personal beliefs shaping practice. A majority of participants in Canada and the Netherlands still prescribe opioids to 99% to 100% of their surgical patients, which is in contrast to many Japanese orthopaedic surgeons who perceive opioids to be unnecessary for managing postoperative pain. Variations in prescribing practices between Canadian, Dutch, and Japanese orthopaedic surgeons emanate from individual, patient, and system-level disparities. Factors such as knowledge gaps, concerns about patient satisfaction, fear of undertreating pain, or perceived lack of alternative pain management options may influence prescribing decisions. We identified barriers at each level which can be addressed via a multifaceted approach that focuses on improving patient and provider education, implementing standardized pain management protocols within healthcare institutions, fostering better communication between primary care physicians and orthopedic surgeons, and establishing updated opioid prescribing guidelines and practice standards tailored specifically for knee and hip arthroplasty surgeons. Future studies can focus on evaluating strategies for addressing the aforementioned barriers to support surgeons in adopting

evidence-based, patient-centered approaches to pain management that prioritize minimizing opioid use while optimizing pain control. Additionally, more rigorous studies are needed evaluating patient and surgeon education on opioid use and prescribing, respectively, as components of a multimodal pain management protocol.

CONCLUSIONS

This thesis provides insights into the complex landscape of opioid use and reduction in the context of knee and hip replacement surgery. It underscores the importance of considering patient and surgeon perspectives to develop comprehensive and effective strategies for opioid reduction following orthopaedic surgery. Chapter 2 highlights the critical role of patient beliefs and perceptions in shaping their willingness to accept alternative pain management approaches. Specifically, patients who expressed concerns about intolerable pain were more resistant to reducing or eliminating opioids, and some patients expressed dissatisfaction with using reduced or no opioids for their postoperative care. These findings align with those of Chapter 3, indicating that orthopaedic surgeons in Canada and the Netherlands share similar concerns regarding patient satisfaction, perceptions of pain, and expectations related to opioid analgesics. Surgeons in these countries expressed concerns that patients might be dissatisfied when prescribed reduced or no opioids, perceive pain as unbearable, or anticipate to be pain-free following surgery. These barriers underscore the need for targeted educational interventions for patients to improve their understanding of the benefits and limitations of opioids and non-opioid alternatives and appropriate expectations of postoperative pain control. Notably, orthopaedic surgeons in Japan noted

that patients exhibit cultural reluctance towards opioid use, which stands in stark contrast to patients surveyed in Canada in Chapter 2, who consider opioids to be essential for pain management. Surgeons' beliefs about how patients perceive and understand opioid use may, in turn, influence their prescribing practices. Cultural factors may underpin disparities in opioid prescribing and use among patients and prescribers. Nonetheless, our cross-sectional study did not collect data on patients' ethnic and cultural backgrounds. Future avenues for research may include exploring how cultural beliefs, values, and norms influence patients' acceptance and preferences for opioid medications in different regions and populations. Understanding these cultural variations can provide valuable insights into the factors that shape prescribing practices, patient-provider communication, and shared decision-making which can help develop tailored and culturally sensitive strategies for pain management, reducing opioid reliance.

The two chapters emphasize the need for a multifaceted approach to address patient and surgeon-identified barriers. Specifically, both patient and prescriber education can improve understanding and dispel misconceptions about opioids and non-opioid alternatives. Orthopaedic surgeons also highlighted the need for further education on identifying abuse, managing pain for vulnerable patients, relevant updates in the literature, and multimodal strategies. Additionally, implementing standardized pain management protocols within healthcare institutions may help promote consistent and evidence-based practices. This can be supplemented by developing updated opioid prescribing guidelines and practice standards tailored specifically for knee and hip arthroplasty surgeons and enhancing knowledge translation and dissemination efforts. More rigorous studies, such as

randomized control trials, are warranted to evaluate the effectiveness of a multifaceted approach, consisting of the strategies mentioned earlier, to facilitate opioid mitigation after TJA. Continued research will be instrumental in refining and advancing these approaches to meet the evolving needs of patients and orthopaedic surgeons.