Wait Times, Resource Use and Patient-Reported Outcomes for Patients Referred for Total Knee Replacement Surgery

Kate Lebedeva
The University of Western Ontario

Supervisor
Bryant, Dianne
The University of Western Ontario Co-Supervisor
Marsh, Jacquelyn
The University of Western Ontario

Graduate Program in Health and Rehabilitation Sciences
A thesis submitted in partial fulfillment of the requirements for the degree in Master of Science
© Kate Lebedeva 2018

Follow this and additional works at: https://ir.lib.uwo.ca/etd

Part of the Health Services Administration Commons, Health Services Research Commons, Patient Safety Commons, and the Public Health Education and Promotion Commons

Recommended Citation
https://ir.lib.uwo.ca/etd/5980

This Dissertation/Thesis is brought to you for free and open access by Scholarship@Western. It has been accepted for inclusion in Electronic Thesis and Dissertation Repository by an authorized administrator of Scholarship@Western. For more information, please contact wlsadmin@uwo.ca.
Abstract

This prospective cohort study evaluated the usual care pathway for patients referred to total knee arthroplasty (TKA). We measured healthcare resource use, costs, and health-related quality of life (HRQoL) over the continuum of care. We also determined the proportion of inappropriate referrals and estimated wait times for initial surgical consultation and TKA.

We found that two in five patients referred to specialty care were deemed inappropriate surgical candidates. Prior to referral, few conservative treatment options were tried, and many imaging tests ordered by referring providers were unjustified. Overall, the greatest proportion of costs was borne by the patient or private insurer, with the minority incurred by the public payer. Surgery was associated with improved HRQoL. The results of this study can provide valuable guidance on the design and implementation of a new electronic referral pathway (NRP) to promote appropriate and timely referral and manage excessive wait times for TKA.

Keywords

Osteoarthritis, total knee arthroplasty, referral, consultation, quality of life, healthcare costs, waiting lists, resource allocation
Co-Authorship Statement

This study was designed in collaboration with Dr. Dianne Bryant, Dr. Jacquelyn Marsh, and Laura Churchill. Together with Dr. Bryant and the staff at EmPower Health Research Inc., we created the study questionnaires for the online database. I was solely responsible for screening and recruiting patients and conducting follow-up assessments. I wrote the original draft of the manuscript, which Dr. Bryant and Laura Churchill then reviewed and provided critical feedback before submission.
Acknowledgments

I would first like to thank my supervisor and co-supervisor, Dr. Dianne Bryant and Dr. Jacquelyn Marsh, as well as my fellow graduate student, Laura Churchill, for their mentorship, dedication and unfailing support over the last two years. I am sincerely grateful to Dr. Bryant for providing the incredible opportunities that made my graduate studies particularly enriching. I attribute the level of my thesis to her expertise and remarkable ability to work around the clock. I would also like to acknowledge the staff and students at University Hospital for their unwavering support every step of the way:

- My fellow graduate students. Special thanks to Bryn, Codie and James for their friendship and patience.
- Sandra Wimperis, Karen Hawkins, and all the nursing and administrative staff at the pre-admission and joint replacement clinics for their accommodation and keen assistance.
- The orthopedic surgeons, residents and fellows for their time, effort and good humour.
- My friends, Mom, Dad and Nick for their encouragement, reassurance and inspiration.
- All participating patients for their time and contributions to this study.
# Table of Contents

Abstract ................................................................................................................................. i
Co-Authorship Statement ........................................................................................................ ii
Acknowledgments .................................................................................................................. iii
Table of Contents ..................................................................................................................... iv
List of Tables ................................................................................................................................ viii
List of Figures ........................................................................................................................ ix
List of Appendices .................................................................................................................. x
List of Abbreviations ............................................................................................................... xi
Chapter 1 ................................................................................................................................... 1
  1 Introduction ......................................................................................................................... 1
Chapter 2 ................................................................................................................................... 4
  2 Literature Review .................................................................................................................. 4
    2.1 Evidence-to-Practice Gap in Primary Care Management of OA ................................... 4
      2.1.1 Clinical Practice Guidelines for the Management of OA ...................................... 4
        2.1.1.1 Summary and Comparison of Guidelines ...................................................... 5
        2.1.1.2 Quality of Guideline Development and Reporting ..................................... 7
      2.1.2 Inappropriate Referral for TKA .............................................................................. 8
        2.1.2.1 Contradicting Treatment Recommendations ............................................. 8
        2.1.2.2 Lack of Practical Guidelines ....................................................................... 9
        2.1.2.3 Incongruity of Guidelines with Primary Care Practice ............................. 11
        2.1.2.4 Limited Guidance on Multidisciplinary Management of OA .................. 12
        2.1.2.5 Inadequate Training in Administering Joint Injections .............................. 14
        2.1.2.6 Misperceptions about Indications and Outcomes of TKA ....................... 15
        2.1.2.7 Failure to Engage Patients in Shared-Decision Making ......................... 17
4.3 Outcome Measures ..................................................................................48
  4.3.1 Patient Demographics......................................................................48
  4.3.2 Healthcare Resource Use..............................................................48
  4.3.3 Health-Related Quality of Life.......................................................49
  4.3.4 Costs ..........................................................................................51
  4.3.5 Surgical Consultation Form...........................................................52
4.4 Estimation of Sample Size .......................................................................53
4.5 Data Analysis .........................................................................................53

Chapter 5 .....................................................................................................55

5 Results .....................................................................................................44
  5.1 Primary Objective................................................................................60
    5.1.1 Healthcare Resource Use..............................................................60
      5.1.1.1 Conservative Treatments.....................................................60
      5.1.1.2 Diagnostic Imaging ............................................................63
    5.1.2 Costs .........................................................................................64
    5.1.3 Quality of Life ...........................................................................70
  5.2 Secondary Objective.............................................................................73
    5.2.1 Proportion of Inappropriate Referrals .........................................73
    5.2.2 Wait Times .................................................................................74

Chapter 6 .....................................................................................................76

6 Discussion ..................................................................................................76
  6.1 Limitations ..........................................................................................80

Chapter 7 .....................................................................................................81

7 Conclusion ..................................................................................................81
  7.1 Future Directions ..................................................................................81
References ........................................................................................................................................82
Appendices .....................................................................................................................................94
List of Tables

Table 1: Key quality and reporting features of leading guidelines for the management of OA……6

Table 2: Themes identified in a review of studies on e-learning for the training of healthcare professionals in self-management support provision to patients with chronic conditions ............25

Table 3: Patient perspectives on e-referral systems in Alberta...............................................36

Table 4: Characteristics of an ideal e-referral system.................................................................37]

Table 5: Demographic characteristics of study participants .......................................................59

Table 6: Patient-reported use of conservative treatments at different stages of care...............61

Table 7: Patient-reported use and results of diagnostic imaging tests at different stages of care....63

Table 8: Costs over the continuum of care by payer perspective ................................................64

Table 9: QoL questionnaire scores at four stages along the continuum of care .........................70

Table 10: Surgical appropriateness of new consults and new referrals .....................................73

Table 11: Willingness to undergo surgery at referral and initial consultation............................74

Table 12: Wait times (in months) from referral to initial consultation (WT1) and from date of inclusion on surgical wait list to TKA (WT2).................................................................75
List of Figures

Figure 1: Key features, relevant stakeholders and intended outcomes of the NRP ...............42

Figure 2: Outcome measures and follow-up frequencies for the four patient groups ..........47

Figure 3: Participant flow through the study .................................................................58

Figure 4: Knee OA-related costs over the continuum of care (unadjusted means, 95% CIs) ..67

Figure 5: Distribution of direct and indirect costs of OA at initial surgical consultation.......68

Figure 6: Distribution of direct and indirect costs of OA prior to surgery ......................68

Figure 7: Distribution of direct and indirect costs of OA at long-term follow-up for patients who had undergone surgical treatment vs. those who had not .........................................................69

Figure 8: Change in EQ-5D index and VAS scores over the continuum of care (unadjusted means, 95% CIs) ...........................................................................................................71

Figure 9: Change in SF-12 PCS and PCS over the continuum of care (unadjusted means, 95% CIs) ......................................................................................................................72

Figure 10: Change in WOMAC scores over the continuum of care (unadjusted means, 95% CIs) ..........................................................................................................................72
List of Appendices

Appendix A: Ethics Approval Form .................................................................................................................94
Appendix B: Letter of Information and Consent .............................................................................................94
Appendix C: Patient Questionnaires ..............................................................................................................Error! Bookmark not defined.
Appendix D: Surgical Consultation Form .........................................................................................................118
Appendix E: Cost Estimate Calculations for Prescription and Over-the-Counter Drugs .........................119
## List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAOS</td>
<td>American Academy of Orthopedic Surgeons</td>
</tr>
<tr>
<td>ACR</td>
<td>American College of Rheumatology</td>
</tr>
<tr>
<td>AGREE II</td>
<td>Appraisal of Guidelines for Research and Evaluation II</td>
</tr>
<tr>
<td>CI</td>
<td>Confidence Interval</td>
</tr>
<tr>
<td>CIAC</td>
<td>Central Intake and Assessment Clinic</td>
</tr>
<tr>
<td>CMA</td>
<td>Canadian Medical Association</td>
</tr>
<tr>
<td>CPG</td>
<td>Clinical Practice Guideline</td>
</tr>
<tr>
<td>CT</td>
<td>Computed Tomography</td>
</tr>
<tr>
<td>ET</td>
<td>Exercise Therapy</td>
</tr>
<tr>
<td>EULAR</td>
<td>European League Against Rheumatism</td>
</tr>
<tr>
<td>GP</td>
<td>General Practitioner</td>
</tr>
<tr>
<td>GPR</td>
<td>General Practitioner Registrar</td>
</tr>
<tr>
<td>HA</td>
<td>Hyaluronic Acid</td>
</tr>
<tr>
<td>HRQoL</td>
<td>Health-Related Quality of Life</td>
</tr>
<tr>
<td>IA</td>
<td>Intra-Articular</td>
</tr>
<tr>
<td>ICC</td>
<td>Intraclass Correlation Coefficient</td>
</tr>
<tr>
<td>iKT</td>
<td>Integrated Knowledge Translation</td>
</tr>
<tr>
<td>IOM</td>
<td>Institute of Medicine</td>
</tr>
<tr>
<td>IPDAS</td>
<td>International Patient Decision Aid Standards</td>
</tr>
<tr>
<td>IQR</td>
<td>Interquartile Range</td>
</tr>
<tr>
<td>KT</td>
<td>Knowledge Translation</td>
</tr>
<tr>
<td>LHIN</td>
<td>Local Health Integration Network</td>
</tr>
</tbody>
</table>
LRM  Lifestyle Risk Modification
MOHLTC Ministry of Health and Long-Term Care
MRI  Magnetic Resonance Imaging
MSK  Musculoskeletal
TENS Transcutaneous Electrical Nerve Stimulation
NICE National Institute for Health and Care Excellence
NP  Nurse Practitioner
NRP  New e-Referral Pathway
NSAID  Non-Steroidal Anti-Inflammatory Drug
OA  Osteoarthritis
OARSI  Osteoarthritis Research Society International
OR  Odds Ratio
PT  Physiotherapist
PtDA  Patient Decision Aid
RCT  Randomized Controlled Trial
RR  Relative Risk
SMD  Standardized Mean Difference
SMS  Self-Management Support
TJA  Total Joint Arthroplasty
TKA  Total Knee Arthroplasty
UK  United Kingdom
US  United States
WCIS  Winnipeg Central Intake Service
WOMAC  Western Ontario and McMaster Universities Osteoarthritis Index
WTMS  Wait Time Management Strategy
Chapter 1

1 Introduction

Osteoarthritis (OA) is a prevalent, debilitating and costly disease that results in the degeneration of the structure and function of synovial joints, commonly affecting the knees and hips. As of 2011, nearly 13% of Canadians are living with OA. Total knee arthroplasty (TKA) is a highly cost-effective procedure for patients who suffer from end-stage knee OA and experience debilitating pain and loss of function despite conservative management. The current national wait time benchmarks for total joint arthroplasty (TJA) are 3 months for surgical consultation after referral from a general practitioner (GP), and 6 months for surgery after the decision to operate has been made. Reducing wait times for TJA was identified as one of four priority areas by Canadian First Ministers in 2004 yet, despite recent efforts to improve access to care, the average wait time for TJA continues to exceed the clinically acceptable benchmark. According to the 2017 Fraser Institute Report, the waits between GP referral and surgical consultation (4.5 months) and between referral and surgery (10.4 months) are the longest among all specialties. The growing proportion of Canadians over the age of 65, coupled with recent technological advances in arthroplasty and improved patient outcomes, suggests that the demand for TKA will continue to rise across all age groups.

Excessive wait times for TKA impact patient health and impose an economic burden on both patients and the healthcare system. Previous studies suggest that most patients experience a significant decline in health-related quality of life (HRQoL) while waiting for TKA, and that longer wait times are associated with lower post-operative HRQoL. Furthermore, poorer pre-surgery health status was found to be a significant predictor of worse outcomes and higher costs post-operatively. A 2008 study commissioned by the Canadian Medical Association assessed the economic impact of waiting for four priority procedures and found that wait times for TJA amounted to the highest societal costs. OA-related costs have also been reported to increase with disease severity. A large proportion of these costs can be attributed to patient and caregiver productivity losses, as an estimated 32% of patients waiting to undergo TJA are unable to engage in their usual activities.
societal impact of waiting for TKA underscores the importance of developing innovative strategies to minimize wait times.

Wait times for procedures arise when the demand exceeds the supply and serve to ration access to medical services, particularly within publicly-funded healthcare systems. However, wait times for TKA vary widely not only between but also within provinces. According to the 2014 Wait Time Alliance report, simply increasing funding is an unsustainable strategy to manage wait times; structural changes must also be made in primary care. GPs play a central role in diagnosing knee OA, managing symptoms non-operatively, and deciding who and when to refer to an orthopedic specialist for surgical treatment. Despite the existence of clinical guidelines for the management of knee OA in primary care, a large proportion of patients referred for TKA are inappropriate surgical candidates. Klett et al. reported that 47% of patients referred to an orthopedic surgical screening clinic were unsuitable for TKA and redirected back to their referring GP with recommendations for conservative management. At our centre, the proportion of inappropriate referrals was previously found to be over 40%. The high rate of inappropriate patients referred for TKA may stem from referring physicians’ uncertainty and misperceptions about surgical suitability. A study conducted in the 1990s found that GPs in Ontario widely disagreed about appropriate treatments for knee OA and the indications for TKA referral. Recent surveys indicate that GPs’ perceptions about surgical suitability continue to vary. These findings highlight the need for clear and consistent indications to support GPs in referring appropriate surgical candidates for consideration of TKA.

One approach to managing wait times is to optimize the referral process by reducing the rate of nonsurgical referrals. To inform the development of a new electronic referral or e-referral pathway (NRP), we previously developed and validated a model that can correctly predict whether a patient referred to an orthopedic surgeon is scheduled for TKA in 70% of the cases. The goal of the NRP is to expedite access to specialty care for patients who are sufficiently symptomatic, have exhausted non-operative treatments, and are willing to undergo surgery. To facilitate decision-making in primary care, the NRP will include educational videos to provide patients and GPs with guidance on appropriate diagnostic imaging tests, conservative management options, the surgical procedure, and post-operative expectations. In light of this larger objective, the aim of this study was to measure wait times,
costs, HRQoL, and healthcare resource use among patients with knee OA over the continuum of usual care, prior to the implementation of the NRP.
Chapter 2

2 Literature Review

The two main objectives of this literature review are to: (1) explore the underlying reasons for the current evidence-to-practice gap in primary care that contributes to excessive wait times for TKA, and (2) identify strategies to bridge this gap and translate evidence-based recommendations into practice and inform the design of our proposed NRP. To address the first objective, we will summarize and evaluate the quality of current clinical practice guidelines (CPGs) for the management of knee OA and explore factors contributing to the high rate of inappropriate referrals for TKA, overuse of unwarranted diagnostic imaging tests, and inefficiency of the current referral system. To meet the second objective, we will discuss the tenets of knowledge translation (KT), electronic (e-)learning in patient and provider education, and existing wait time management strategies (WTMS) and e-referral systems. Lastly, we will integrate the findings and apply them to our proposed NRP.

2.1 Evidence-to-Practice Gap in Primary Care Management of OA

Practicing within the constraints of Canada’s publicly-funded healthcare system, GPs must have the skills and expertise to effectively manage the symptoms of knee OA, while judiciously referring select patients to TKA at the appropriate time. To facilitate evidence-based clinical decision-making in primary care, many national and international organizations have published CPGs for the management of knee OA. However, the current misuse of diagnostic imaging tests, inadequate provision of conservative treatments, and inappropriate referral to specialty care indicate that their uptake has been poor. To address these issues and improve the quality of patient care, we must first evaluate existing CPGs to shed light on the barriers to their implementation.

2.1.1 Clinical Practice Guidelines for the Management of OA

According to the Institute of Medicine (IOM), CPGs are “systematically developed statements to assist practitioner and patient decisions about appropriate healthcare for specific clinical circumstances.”32 The five leading guidelines for the conservative
management of knee OA were developed by the OA Research Society International (OARSI)\textsuperscript{33}, the European League Against Rheumatism (EULAR)\textsuperscript{34}, the National Institute for Health and Care Excellence (NICE)\textsuperscript{35} in the United Kingdom (UK), the American Academy of Orthopedic Surgeons (AAOS)\textsuperscript{25} and the American College of Rheumatology (ACR)\textsuperscript{36} in the United States (US).

2.1.1.1 Summary and Comparison of Guidelines

All guidelines consistently recommend that patients be offered a set core conservative treatments before TKA is considered, including a combination of pharmacological and nonpharmacological modalities.\textsuperscript{37} Initially, GPs should provide patients with education on self-management, exercise (including referral to physiotherapy), weight loss, and activity modification. Recommended pharmacotherapy includes non-steroidal anti-inflammatory drugs (NSAIDs), acetaminophen, tramadol, and intra-articular (IA) corticosteroid injections. Only those patients who continue to experience significant pain and functional impairment despite conservative management should be referred to an orthopedic surgeon for consideration of TKA.

To facilitate comparison, Table 1 outlines key quality and reporting features of the five leading CPGs. Despite significant variation in the clinical presentation of OA in different joints, only the OARSI and AAOS guidelines focus specifically on the knee joint. The EULAR guideline focuses on both hip and knee OA, while the NICE and ACR guidelines provide recommendations for the management of knee, hip and hand OA. It is worth noting that the OARSI made the first effort to improve guideline applicability to patients with comorbidities and multi-joint OA by providing separate recommendations for four patient types: (1) knee OA without comorbidities, (2) multi-joint OA without comorbidities, (3) knee OA with comorbidities, and (4) multi-joint OA with comorbidities.

In 2008, the IOM established eight standards for developing high-quality, trustworthy CPGs.\textsuperscript{32} However, there is considerable heterogeneity among guidelines in the methods used to select expert panelists and formulate consensus- and evidence-based recommendations. The IOM emphasized that a balanced, multidisciplinary expert panel is crucial for developing unbiased guidelines\textsuperscript{32}, yet the five panels varied significantly in size (ranging from 11 to 21 members) and the scope of represented disciplines. Furthermore, while patient-centered care
is considered the cornerstone of quality clinical practice, patient values and preferences are not routinely incorporated into the guideline development process. Of the five CPGs, only the NICE and EULAR panels included patient representatives and described their contribution. However, to facilitate interpretation of treatment outcomes, all guidelines except the ACR reported a summary measure of effect size (ES), such as the standardized mean difference (SMD) or odds ratio (OR), with 95% confidence intervals (CIs) when evidence from a meta-analysis was available. CPGs also provided some indication of the strength of recommendations to reflect the quality of supporting evidence and the risks and benefits associated with each treatment.

### Table 1: Key quality and reporting features of leading guidelines for the management of OA

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert panel</td>
<td>n = 13 (5 disciplines)</td>
<td>n = 21 (10 disciplines; 2 patients)</td>
<td>n = 18 (7 disciplines; 2 patients)</td>
<td>n = 11 (4 disciplines)</td>
<td>n = 14 (7 disciplines)</td>
</tr>
<tr>
<td>Development methods</td>
<td>Delphi consensus, RAND/UCLA Appropriateness</td>
<td>Delphi consensus approach</td>
<td>GRADE approach</td>
<td>GRADE approach</td>
<td>GRADE approach</td>
</tr>
<tr>
<td>No. of treatment recommendations</td>
<td>25 (separate for 4 patient types)</td>
<td>11</td>
<td>N/A (bullet-point recommendations)</td>
<td>15</td>
<td>N/A (recommendations outlined in tables)</td>
</tr>
<tr>
<td>No. of recommendations based on grade A evidence</td>
<td>20 of 25 (80%)</td>
<td>9 of 11 (82%)</td>
<td>N/A</td>
<td>6 of 15 (40%)</td>
<td>N/A</td>
</tr>
<tr>
<td>Indications of recommendation strength</td>
<td>Appropriate, inappropriate or uncertain; mean risk and benefit scores (95% CI)</td>
<td>Level of evidence (I-IV); mean level of agreement (95% CI)</td>
<td>Implicit in wording</td>
<td>Strong, moderate, limited, or inconclusive</td>
<td>Strong, weak, or none</td>
</tr>
<tr>
<td>Measures of ES</td>
<td>SMD (95% CI)</td>
<td>SMD (95% CI)</td>
<td>SMD (95% CI)</td>
<td>SMD/OR/raw mean difference (95% CI)</td>
<td>None</td>
</tr>
<tr>
<td>Guideline quality (no. of AGREE II domains met)</td>
<td>1 of 5</td>
<td>3 of 5</td>
<td>5 of 5</td>
<td>1 of 5</td>
<td>1 of 5</td>
</tr>
<tr>
<td>No. of competing interests</td>
<td>2</td>
<td>3</td>
<td>25</td>
<td>35</td>
<td>84</td>
</tr>
</tbody>
</table>
2.1.1.2 Quality of Guideline Development and Reporting

Given the multitude of existing CPGs, two recent systematic reviews have been conducted to evaluate their methodological quality, levels of supporting evidence, and prevalence of competing interests.\textsuperscript{39,40} Methodological quality was assessed using the Appraisal of Guidelines for Research and Evaluation II (AGREE II) instrument\textsuperscript{41}, which consists of six domains:

1. Scope and purpose (overall objective and target population).
2. Stakeholder involvement (guideline development by relevant stakeholders/intended users).
3. Rigour of development (systematic review of the evidence).
4. Clarity of presentation (language, structure, and format).
5. Applicability (potential facilitators and barriers to implementation and cost implications).
6. Editorial independence (bias and competing interests).

Feuerstein et al.\textsuperscript{40} determined whether each CPGs satisfied key quality measures in the first five domains of the AGREE II tool, and assessed the sixth domain separately to discuss issues of editorial independence. Only the NICE guideline proposed strategies to promote uptake into practice (applicability domain), thereby meeting the quality measures in all five domains. The authors reported that conflicts of interest were present in all guidelines (ranging from two in the OARSI to 84 in the AAOS), undermining their methodological transparency and validity. In a similar review, Nelson et al.\textsuperscript{39} evaluated the extent to which CPGs satisfied the AGREE II tool domains (0\% to 100\%) and found that every guideline scored lowest in the applicability domain. Given that the fundamental goal of CPGs is to translate evidence into practice, the lack of emphasis on applicability and implementation seems contradictory to their purpose.

In addition, Feuerstein et al.\textsuperscript{40} also evaluated the quality of supporting evidence using an ABC grading system, in which multiple randomized controlled trials (RCTs) and meta-analyses provide the highest level of evidence (grade A), followed by single RCTs and non-randomized studies (grade B), and lastly expert opinion or case studies (grade C). Given the format of the NICE and ACR guidelines, they could not be mapped onto the ABC system and were therefore excluded. The majority of the EULAR (9 of 11; 82\%) and OARSI (20 of
25; 80%) recommendations were supported by grade A evidence, compared to only 40% (6 of 15) in the AAOS guideline.

The comparison and quality assessment of five highly prominent CPGs demonstrate considerable variability in guideline development methods and a high prevalence of competing interests. However, their overall agreement on most recommendations suggests inadequate dissemination and implementation at the primary care level.

2.1.2 Inappropriate Referral for TKA

Current studies suggest that approximately half of the patients referred for surgical consideration are deemed inappropriate candidates for TKA\textsuperscript{26–28,42}, most often due to insufficient symptoms or OA severity, inadequate conservative management, and unwillingness to undergo surgery.\textsuperscript{27,28} Thus, the mere availability of CPGs appears to be insufficient for evidence-based practice.

The issue of inappropriate referral to TKA is complex and multifactorial and appears to result from an interplay of individual-, local- and system-level factors. The literature offers a plethora of possible factors contributing to the evidence-to-practice gap, including suboptimal CPGs, inadequate family medicine training, ongoing disagreement about the indications for TKA, and failure to assess patient values and preferences prior to referral. To gain a better understanding of the needs of patients and GPs, we will discuss the following shortcomings of current CPGs: contradicting treatment recommendations, impractical and illogical formats, lack of applicability to clinical practice, and limited guidance on the multidisciplinary management of knee OA.

2.1.2.1 Contradicting Treatment Recommendations

Although there is considerable overlap across the multitude of CPGs for OA management, some recommendations are inconsistent. Discrepancies exist in recommendations for the use of IA hyaluronic acid (HA) injections, glucosamine and chondroitin, acupuncture, manual therapy, ultrasound, transcutaneous electrical nerve stimulation (TENS), knee bracing, orthotics, duloxetine, topical capsaicin and lateral wedge insoles.\textsuperscript{39,43} These inconsistencies may be partly explained by the aforementioned variation in the quality of supporting
evidence and methodological rigour across guidelines.\textsuperscript{44,45} Furthermore, some CPGs are often revised\textsuperscript{34,43}, while others may be out of date with the latest research evidence.\textsuperscript{25,36} Although this may instill confusion and mistrust, guidelines consistently recommend a set of core conservative treatments, suggesting that there are other factors that contribute to suboptimal management and inappropriate referral.

\subsection*{2.1.2.2 Lack of Practical Guidelines}

The formats of many CPGs are cumbersome and impractical, posing a major obstacle to uptake and adherence. For instance, the AAOS guideline provides 15 recommendations for the treatment of knee OA in a report that exceeds 1,000 pages.\textsuperscript{25} Recommendations also lack any logical order, given the absence of evidence to support treatment modalities in patients in whom preceding treatments failed to control symptoms.\textsuperscript{46} For example, the most recent OARSI guideline listed treatments in alphabetical order and adopted a rather conservative and arguably uninformative approach by classifying nearly half of the recommendations as “uncertain” (59\% of pharmaceutical and 33\% of nonpharmaceutical treatment recommendations; 47\% in total).\textsuperscript{43} On the other hand, the updated NICE guideline adopted the most user-friendly layout by presenting recommendations succinctly in bullet-point format and incorporating a visual aid depicting a holistic approach to patient assessment.\textsuperscript{35}

An Australian study surveyed GPs (n = 79) to explore their attitudes about national and international CPGs for the conservative management of hip and knee OA, and found that most respondents were either unaware of the guidelines (30\%), never used them (19\%), or rarely used them (34\%).\textsuperscript{47} GPs expressed a strong preference for shorter, electronic, and easily accessible formats such as one-page checklists, summaries, and flowcharts.

Several treatment algorithms have been developed to facilitate the implementation of evidence-based recommendations in primary care.\textsuperscript{33,46,48} In 2014, the European Society for Clinical and Economic Aspects of Osteoporosis and OA task force developed the first detailed clinical algorithm or flowchart to guide referring physicians through the steps of combination therapy.\textsuperscript{46} After reviewing and synthesizing existing CPGs for OA, members of the task force (n = 13) proposed an algorithm consisting of the initial core set (education, exercise, and weight loss) followed by four sequential, multimodal treatment steps. If the core set fails to control symptoms, GPs are to proceed to step 1 and provide
nonpharmacological (referral to physiotherapy, manual therapy, acupuncture, TENS, and walking aids) and pharmacological treatment (acetaminophen and topical NSAIDs). In step 2, patients with persistent symptoms are offered advanced pharmacological modalities (oral NSAIDs and IA injections). In severely symptomatic patients, step 3 involves the last pharmacological attempts before surgical options are considered (duloxetine and short-term weak opioids such as tramadol). Step 4 comprises end-stage disease management (TJA or opioid analgesics if surgery is contraindicated). Although the benefits of acupuncture, manual therapy and TENS are contested, the authors suggest that they may be offered as alternative treatments if surgery is contraindicated or unwanted.

A different approach was adopted by Meneses et al. in 2016, who assembled a multidisciplinary panel of experts (n = 15) from eight countries to develop two case scenarios to represent common clinical presentations of knee OA along with their corresponding treatment algorithms. The panel, which consisted of GPs, physiotherapists (PTs), rheumatologists and orthopedic surgeons, systematically reviewed the most recent CPGs and selected appropriate treatments for each scenario through expert consensus. To promote a patient-centered approach, two individuals with knee OA provided feedback throughout the process. Similar to the task force’s four-step flowchart, the finalized algorithms were presented as schematic decision trees with pharmacological and nonpharmacological treatments in parallel, culminating in referral to surgical consultation “if disabling symptoms and if already exhausted all other options, including pharmacological and nonpharmacological interventions.” They also consider comorbidities and contraindications, encourage referral to a physiotherapy or occupational therapy, the use of assistive devices, IA injections, and opioid therapy prior to referral, and go a step further than existing algorithms by including a long-term, postoperative ET program tailored to the patient’s goals. Although only two algorithms were developed for hypothetical scenarios, they represent common clinical cases and thus provide practical examples of guidelines’ utility and applicability to the primary care context.

Given GP preference for short and easy-to-use formats, treatment algorithms are promising tools for promoting the implementation of evidence-based recommendations. However, their impact on clinical-decision making, and ultimately patient outcomes and healthcare costs, has yet to be determined.
2.1.2.3 Incongruity of Guidelines with Primary Care Practice

Another possible explanation for the poor uptake of CPGs is that they lack relevance to knee OA patients with comorbidities and thus the reality of clinical practice. Current evidence suggests that 68% to 84% of patients with knee OA suffer from at least one other chronic condition.\(^\text{49-51}\) A Canadian epidemiological study of primary care patients with OA (n = 29,592) found that hypertension, diabetes, and chronic obstructive pulmonary disease were the most common conditions associated with the diagnosis of OA.\(^\text{51}\) Furthermore, a recent systematic review revealed a high prevalence of anxiety and depression among patients with knee OA.\(^\text{52}\) Both psychological and physiological comorbidities may serve as contraindications to certain treatments for knee OA, contribute to noncompliance, and lead to higher levels of pain and disability\(^\text{49,50,52,53}\), thereby posing a unique challenge to the management of knee OA.

Despite exercise therapy (ET) being a core conservative for knee OA, GPs often hesitate to offer it to patients with comorbidities due to concerns about aggravating the symptoms of the other condition(s).\(^\text{53}\) Given the marked prevalence of comorbidity in patients with knee OA, Rooij et al.\(^\text{53}\) conducted the first RCT to investigate the safety and efficacy of tailored ET on physical functioning in this patient group compared to usual care (n = 63/group). The most prevalent comorbidities were obesity (61%), cardiovascular disease (36%), and chronic obstructive pulmonary disease (32%). Patients in the intervention group participated in a five-month ET program that consisted of comorbidity-adapted aerobic and strengthening exercises and training of daily activities under the supervision of a PT (two 30- to 60-minute sessions per week). ET was adapted by changing the frequency, intensity, timing, and types of exercises both pre-intervention (through an extensive assessment of restrictions and contraindications) and throughout the intervention (by monitoring comorbidity-related symptoms at every session). The primary outcome measures were the Western Ontario and McMaster Universities OA Index (WOMAC) physical functioning subscale score and the 6-minute walk test assessed at baseline, five months (directly post-intervention) and eight months. The overall, between-group difference was statistically significant for both outcomes (WOMAC: -7.43, 95% CI -9.99 to -4.87; p < 0.001; and 6-minute walk test: 34.16 meters, 95% CI 17.68 to 50.64; p < 0.001). The large between-group ES for physical functioning observed directly post-intervention (SMD 0.9), with an even further improvement three
months post-intervention (SMD 1.0), suggest that tailored ET programs that take the necessary precautions are not only safe but can also greatly benefit patients with knee OA and comorbidities.

The lack of applicability of current CPGs largely stems from the imbalance between internal and external validity in the underlying research. Although systematic reviews and meta-analyses of RCTs provide the highest level of evidence, RCTs often exclude participants with comorbidities, giving precedence to internal validity over generalizability. As a result, guidelines rely on unrepresentative samples, thereby providing simplified treatment recommendations that are inapplicable to a large subset of patients.

Thus, future CPGs and other efforts to improve the quality of knee OA care must explicitly address the highly prevalent comorbidities and their compounding effect on management options and patient outcomes by promoting a holistic and individualized approach. Although the latest OARSI guideline acknowledges the interplay between knee OA, comorbidities and treatment effectiveness by providing separate recommendations for four patient types, the broad groupings are likely insufficient for a truly personalized approach to patient care.

2.1.2.4 Limited Guidance on Multidisciplinary Management of OA

Given that knee OA is a chronic and multifactorial disease with diverse symptom manifestation, its effective management requires an integrated multidisciplinary approach. While most CPGs explicitly recognize the importance of multimodal treatment pathways, they provide no practical guidance on the coordination and delivery of care across disciplines. Recent surveys suggested that this cultivates misperceptions among GPs about the roles that allied health professionals play in the management of OA, thereby contributing to the issues of suboptimal patient care and inappropriate referral to TKA. Recognizing the paucity of detailed CPGs, the EULAR expert panel developed comprehensive recommendations for the nonpharmacological management of hip and knee OA, in which they specified the content, timing, frequency, duration, and delivery of each treatment. Although it encouraged multidisciplinary and individualized care, it provided no advice on how various providers should collaborate and integrate their care. Similarly, the
updated NICE guideline emphasizes a holistic approach to the diagnosis and management of OA, yet does not clarify the roles of different providers.35

An online survey of GPs across the UK (n = 232) explored adherence to national guidelines and barriers to providing quality care for patients with OA.58 Although most respondents (65%) rated the NICE guidelines as the primary source of information that guided their practice, only 15% felt that they were managing OA effectively. Similarly, approximately half (48%) reported using educational materials with patients, yet only a third felt that their educational material was adequate. The most commonly cited barriers to optimal management of OA were difficulty achieving adequate pain control and a lack of time.

A similar study explored the attitudes, beliefs, and behaviors of GPs (n = 835) across the UK regarding the use of ET for OA, including advice on general or local exercise and referral to physiotherapy.60 Attitudes and beliefs were measured on a five-point Likert-type scale, while behaviors were assessed using a clinical vignette of a 58-year-old female patient with her first presentation of gradually worsening bilateral knee pain. Most GPs appeared to believe in the safety and benefits of ET, with 87% recommending some type of exercise for the vignette patient. However, only 5% explicitly stated that their advice would be tailored to patient’s interests and abilities. Furthermore, reported behaviours were not aligned with the NICE guideline, as only 11% provided written information on exercise or referred to physiotherapy. This is not surprising, given that only 61% of GPs reported having read the national guideline.59 Furthermore, the overwhelming majority (98%) described several barriers to ET use, including insufficient time, a lack of expertise, and uncertainty about the most appropriate types of exercise and the range of services offered by PTs.

These findings indicate a need for strategies to disseminate evidence-based recommendations and clarify the roles of GPs and other providers, especially considering that both studies likely overestimated adherence to guidelines due to response bias (given low response rates), reliance on self-report, and a subset of GPs (8% and 6%) having a special interest (i.e., additional training and experience) in musculoskeletal (MSK) conditions.
2.1.2.5 Inadequate Training in Administering Joint Injections

A considerable proportion of inappropriate referrals consists of patients who have not exhausted conservative treatments, including IA joint injections. Patients with knee OA are routinely treated with corticosteroid and HA injections, which can be performed by a variety of healthcare providers, including GPs, advanced practice PTs, physiatrists, podiatrists, rheumatologists and orthopedic surgeons. IA corticosteroid injections may provide short-term relief of moderate to severe pain in patients with knee OA, and are generally recommended as an adjunct to core treatments. Although HA injections may alleviate mild knee pain for up to 24 weeks, current recommendations for this procedure are inconsistent, with some guidelines advising against their use, while others provide uncertain recommendations and encourage patient-physician shared decision-making to determine whether they may have merit.

Klett et al. evaluated the impact of a screening clinic for patients with knee OA referred for TKA and identified the conservative treatments used prior to referral. Nearly half of the patients were referred back to their GP with recommendations for nonoperative management. Corticosteroid injections were suggested for 45% of inappropriate referrals, while appropriate surgical candidates were significantly more likely to have tried injections (59% vs. 32%; p < 0.001). Previous use of IA injections was also found to be predictive of surgical appropriateness at our center, as patients who had tried injections were about 1.5 times more likely to be scheduled for TKA at their initial consultation (OR 1.79, 95% CI 0.93 – 3.43 in the training data set, and OR 1.65, 95% CI 0.86 – 3.19 in the validation model). In line with these studies, Jolly and Curran found that primary care physicians underused IA injections in the management of arthritis due to inadequate training and discomfort with the technique. Physicians practicing at a university hospital (n = 55; 36 residents and 19 faculty members) completed a questionnaire querying training, experience, and comfort in administering joint injections. Despite widely supporting the use of IA injections for severe arthritis, only 19% of respondents had performed the procedure themselves and most (90%) referred patients to specialists (48% referred to rheumatologists, 12% to orthopedic surgeons, and 29% to both). With a mean comfort score of 4.5 (on a scale from 0 – 10), primary care providers cited discomfort with performing injections as the main reason for referral requests. The overwhelming majority (95%) of respondents believed that
their training was inadequate, and only 40% of residents had received a lecture on joint injections in medical school or a demonstration during residency.

Given the central role that GPs play in managing knee OA nonoperatively, education and training in joint injection techniques would enable them to perform injections. Alternatively, simply providing access to a list of local GPs or advanced practice PTs who administer injections may effectively eliminate a subset of unnecessary referrals to specialty care.

2.1.2.6 Misperceptions about Indications and Outcomes of TKA

The persistent lack of consensus on indications for surgery appears to be a major contributor to the issue of inappropriate referral. Throughout the last two decades, numerous studies have consistently demonstrated wide variations in the perceptions of physicians in Ontario regarding patient candidacy for TKA and the risks and benefits of surgery, not only between but also within specialties.29–31,65

In 1996, Attard et al.29 surveyed a random sample of urban and rural GPs (n = 126), rheumatologists (n = 67) and orthopedic surgeons (n = 234) in Ontario to explore their opinions on indications for TKA and its outcomes. Respondents rated the extent to which 32 patient characteristics (identified through a literature review and surgical expertise) influenced their decision to refer for, or perform, TKA on a five-point Likert-type scale, ranging from “much less likely” to “much more likely”. In addition, perceived effectiveness of TKA was based on physicians’ estimates of the proportion of patients that would experience various outcomes, both positive and negative. There was significant disagreement between surgeons and GPs regarding both surgical candidacy and the outcomes of TKA. For most of the patient characteristics, GPs were more likely to refer for surgical consideration than surgeons were to perform TKA, whereas surgeons were more optimistic about the effectiveness of surgery than GPs. Results also revealed physicians within specialties disagreed on many indications for TKA (GPs disagreed on 12 of the 32 patient factors, rheumatologists on 10, and surgeons on seven).

More recently, Wright et al.30 determined how much of this variability was attributed to inconsistencies in the opinions of individual physicians. Similar to the previous study, GPs (n = 165), rheumatologists (n = 111), and surgeons (n = 109) rated the effect of 34 patient
characteristics on their decision-making about referring for, or performing, TKA. Physicians also rated their “anxiety due to uncertainty” and “reluctance to disclose uncertainty to patients” using a five-point Likert-type scale. To determine the reliability of individual responses, a subset of participants (n = 186) completed the questionnaire again after six weeks. Consistent with previous findings, physicians disagreed on indications for TKA. However, half of the variability was attributed to disparities in their individual opinions reported merely six weeks apart (intraclass correlation coefficient [ICC] 0.49, range 0.11 – 0.79). Despite poor inter-rater agreement, neither GPs nor surgeons acknowledged any uncertainty in their opinions. Withholding relevant information regarding treatment decisions, including feelings of uncertainty, reflects a paternalistic approach that prevents patients from engaging in shared decision-making and leads to unnecessary referrals.

In 2016, Waugh et al.\textsuperscript{31} reiterated the results of these surveys, finding that the perceptions of referring GPs (n = 212) regarding patient indicators of appropriateness and the outcomes of TJA continue to vary widely in Ontario. This study adds to the existing literature by providing insights into GP predictors of low confidence in determining patient candidacy for surgery. Despite marked dissonance in reported outcomes, GPs generally overestimated both the risks and benefits of TJA. Nearly a quarter of respondents (22%) was uncertain about the risk of at least one major complication, while 77% overestimated the revision rate and believed that prosthesis survivorship was <15 years. GPs reported moderate confidence levels in deciding whom and when to refer for TJA (mean score of 6.95 on a scale from 1 – 10), and approximately half (44%) were unsure about surgical indications and identified this as a major barrier to referral. Low confidence (i.e., score ≤6) was significantly associated with being female (OR 2.18, 95% CI 1.06 – 4.46; p = 0.03) and reporting a lack of clarity regarding indications for TJA (OR 3.54, 95% CI 1.87 – 6.66; p < 0.0001). Interestingly, other factors such as clinical experience (≤15 vs. >15 years of practice), group vs. solo practice and urban vs. rural practice, were not predictive of low confidence.

Citing the excessive wait times for TJA in Ontario, Hudak et al.\textsuperscript{65} provided an alternative explanation for the lack of consensus on surgical indications based on the argument that many appropriate candidates are not offered surgery. The decision-making processes that dictate patient candidacy for TJA were explored using focus groups and in-depth interviews with GPs.
The findings suggested that the decisions around surgical suitability entail more than simply identifying appropriate patients and are influenced by system-level factors, such as limited operating room time and lack of postoperative care. Presuming that not everyone who requires TJA will undergo surgery, the authors argue that physicians are obliged to engage in “medical brokering” to ration limited healthcare resources in our constrained healthcare system. With an excess number of appropriate surgical candidates, physicians must prioritize patients and determine the best candidates for TJA using their own criteria. This argument implies that each referral decision constitutes a dilemma for GPs, as institutional constraints force them to adopt the role of gatekeepers to scarce specialist services, which conflicts with their fiduciary duty to act in the best interests of individual patients. Yet, by arguing that many suitable patients are not offered surgery, the authors do not address the abundance of inappropriate referrals. Nevertheless, this study reiterates the need for the development of surgical appropriateness criteria to render the referral process more transparent and ensure equitable resource allocation.

2.1.2.7 Failure to Engage Patients in Shared-Decision Making

Misperceptions about surgical indications and outcomes are the leading causes of the observed uncertainty among GPs, whose hesitation to discuss the possibility of TKA with patients results in the frequent referral of patients who do not intend to undergo surgery.

A population-based cohort study found that 66% (250 of 379) of individuals with disabling hip and knee OA unwilling to consider TJA as a treatment option. Unwillingness was strongly associated with misperceptions about indications for surgery and postoperative outcomes. A previous study at our center found that 13.7% (28 of 203) of patients were unwilling to undergo surgery at their initial surgical consultation, compared to 30.7% of inappropriate referrals. Using a training and validation sample (n = 203/sample), the authors developed and cross-validated a model to predict whether patients referred to TKA were scheduled for surgery at their initial consultation. Willingness to undergo surgery was the strongest predictor of surgical suitability. In the training sample, patients who were willing to undergo surgery were about 4.5 times more likely to be scheduled for TKA (95% CI 1.64 – 12.08; p = 0.003). The validation sample further supported the results, in which
willing patients were approximately 10 times more likely to be scheduled for surgery (95% CI 3.01 – 31.71; p < 0.001).

As a result of GPs ceding the responsibility of information provision to orthopedic surgeons, the large proportion of referrals unwilling to undergo surgery needlessly wait for surgical consultation, only to be redirected back to primary care management. This leads not only to postponed conservative treatment for nonsurgical referrals, but also increased wait times for appropriate candidates in need of TKA. Patient and GP education on surgical suitability and the risks and benefits of TKA could therefore avoid many unnecessary referrals, thereby improving access to specialty care.

2.1.3 Unwarranted Ordering of Diagnostic Imaging Tests

Another issue resulting from the evidence-to-practice gap in primary care is the ordering of inappropriate imaging tests for the diagnosis of OA, specifically magnetic resonance imaging (MRI). Between 1996 and 2006, the annual use of MRI has increased six-fold in Canada, with GPs ordering 20% of MRI examinations.67

CPGs for the diagnosis and management of OA have evolved over time, with older guidelines recommending plain radiographs (bilateral anteroposterior weight-bearing, semiflexed posteroanterior, lateral, and patellofemoral views).61,68 However, the latest NICE guideline states that the diagnosis of OA be made clinically without imaging tests if patients meet the following three criteria: (1) are ≥45 years of age, (2) experience activity-related joint pain, and (3) either experience no morning joint-related stiffness or morning stiffness that lasts <30 minutes.35 The American College of Radiology and Canadian Association of Radiology have also published national practice guidelines that provide indications (by imaging modality and by organ system) to assist providers in ordering appropriate imaging tests.69,70 MRI is generally not indicated for the diagnosis of OA, but may be useful if a rare condition is suspected (e.g., osteochondritis dissecans, avascular necrosis, or pigmented villonodular synovitis).68,71 Despite clear evidence-based recommendations for the ordering of diagnostic imaging tests, MRI has been increasingly used to diagnose knee OA in primary care leading to increased costs and wait times.72
A retrospective review of elective outpatient computed tomography (CT) and MRI examinations ordered by GPs in the US found that 14% the knee MRI scans (5 of 36) were unwarranted according to evidence-based appropriateness criteria.73 Similarly, a US study of new referrals presenting with knee pain (n = 599) to an academic orthopedic sports medicine clinic found that nearly a quarter of patients (22%) underwent MRI prior to referral, often without having preexisting weight-bearing radiographs.74 Only 58% of patients had obtained plain radiographs before MRI, of which just 13% were appropriate (i.e., weight-bearing). Orthopedic surgeons evaluated the results of the weight-bearing radiographs, which were ultimately obtained for all participants, as well as the appropriateness of pre-referral MRI. Among patients whose radiographs revealed >50% joint space narrowing, almost all MRI scans (95%) were deemed unnecessary and had no impact on treatment recommendations.

On the other hand, some studies have argued for the diagnostic utility of MRI in detecting early, pre-radiographic OA. The review by Favero et al.75 suggests that MRI is important for earlier diagnosis of OA given its ability to detect structural changes not only in the periarticular bone and cartilage, but also in the menisci, synovium, and ligaments. The authors argue that, by visualizing cartilage defects and bone marrow lesions, MRI can identify patients at a high risk of OA progression and enable early initiation of preventative management. Given that conservative treatments may effectively relieve symptoms in the early stages of OA, appropriate and timely diagnosis offers an opportunity to influence modifiable risk factors to prevent the later degenerative changes that would have already occurred once OA is detected clinically or radiographically.62 This is especially crucial for alleviating pain and maximizing the QoL in younger patients, for whom surgical options are limited. However, a systematic review and meta-analysis of studies evaluating the diagnostic performance of MRI in OA concluded that its sensitivity is below that of clinical and radiographic diagnoses.72 Given that the latter are more cost-effective and considered the diagnostic standard, the use of MRI for the routine diagnosis of OA is unjustified. In addition to often being clinically irrelevant, MRI findings may also lead to futile treatment. Incidental meniscal tears are common in older people, including those without any symptoms and patients with painful OA.74 Thus, the overuse of MRI can result in the increased detection of meniscal tears and unnecessary arthroscopic knee surgery in asymptomatic individuals.71
Given the recent increase in wait times for CT and MRI in Ontario, You et al. explored physicians’ attitudes about the use of these imaging tests. Through one-on-one teleconference interviews with GPs, specialists and radiologists (n = 19), the authors identified two predominant issues: (1) non-clinical reasons for ordering scans, and (2) communication among physician groups. Non-clinical reasons for ordering CT and MRI scans included practicing “defensive medicine” (fear of being sued for a delay in diagnosis), indeterminate imaging reports (which make written recommendations for further diagnosis), patient demand (ordering tests to satisfy or reassure patients), supply-induced demand (improved access to CT and MRI driving increased patient demand and expectations), and significant variation in ordering practices within specialties (indicating variation in perceived indications for imaging tests). The second theme reflected participants’ feelings of increasing isolation between ordering clinicians and radiologists (due to poor written and verbal communication), as well as GPs and specialists working in solos (as each physician group blamed the other for the overuse of CT and MRI scans). With only 19 participating physicians, these findings are preliminary; however, they shed light on several deficiencies of the current healthcare system and reiterate the need for patient and physician education as well as strategies to facilitate inter-disciplinary communication.

2.1.4 Inefficiency of Current Referral Systems

Appropriate and timely access to specialty care requires informative and efficient communication among providers. However, national physician surveys suggest that current referral systems have much room for improvement. The significant variation in referral processes between, and even within, specialties and geographic areas contributes to the poor access to specialty care.

National physician surveys were conducted to identify the main shortcomings of existing referral systems across Canada. The CMA drafted a policy statement regarding referral and barriers to accessing specialty care based on the results of an unpublished 2012 survey of GPs and specialists (n = 3,000). The 2010 National Physician Survey consulted GPs (n = 6,602) and other specialists (n = 32,096) across Canada about sending and receiving referral requests. Both surveys revealed widespread dissatisfaction and considerable variation in referral request processes. Results suggest that specialists differ in their requirements for
accepting referral requests (e.g., use a specific referral form or communication method),
while referring physicians vary widely in the quality of information provided in referral
requests (i.e., the degree to which information is sufficient, up-to-date, and relevant). There
was a notable discrepancy in perceptions of referral request completeness; the vast majority
of GPs felt that they provided all the necessary information, whereas less than half of
specialists agreed (91% vs. 47%). Among all physician groups, GPs were the least satisfied
with the referral process, with only 43% considering it effective. Many GPs (67%) identified at least one issue involving insufficient information as a major source of frustration
(e.g., not being informed by specialists about referral receipt, patient’s appointment,
treatments plan, and requested services not being offered). On the other hand, over half of
all specialists (53%) reported frustration with the lack of information in referral requests
(e.g., regarding test results, reason for referral, and previous treatments).

Inadequate information provision and a lack of standardization in the current referral process
is problematic. e-Referral systems would effectively address these issues by streamlining the
referral process and facilitating inter-provider communication, thereby improving referral
efficiency and ultimately access to specialty care.

2.2 Strategies to Bridge the Evidence-to-Practice Gap

The literature suggests that issue of excessive wait times for TKA largely results from
suboptimal primary care and inefficient referral systems. Improving access to specialty care
requires the development of innovative models of care. Given the paradigm shift in modern
medicine towards electronic interactions, we proposed a NRP that engages patients and GPs
to streamline the referral process. We must therefore consider the theoretical underpinnings
of KT and elucidate the factors that may impact is uptake and sustainability.

2.2.1 Knowledge Translation

At the Canadian Institutes of Health Research (CIHR), KT is defined as “a dynamic and
iterative process that includes the synthesis, dissemination, exchange, and ethically sound
application of knowledge to improve the health of Canadians, provide more effective health
services and products, and strengthen the healthcare system.” Graham and Tetroe —
leadings KT experts at the CIHR – acknowledge that the healthcare system consists of complex interactions among researchers, policymakers, healthcare providers, administrators and patients. As such, they argue that bridging the “knowledge transfer gap”, or transferring research findings into practice, is often a slow and disorganized process, and recommend that it be guided by theories or frameworks. To support practice change efforts, the authors conducted a focused literature search and identified 31 planned action theories, which are models that rationalize and systematically structure activities to cause change. The theory analysis of these models revealed many common action steps: identifying the problem, identifying the target audience, assessing barriers to using the knowledge, reviewing evidence, tailoring interventions, implementing the program, and evaluating the process and outcomes. The knowledge-to-action cycle was derived from these results and illustrates the interconnected elements of KT centered around knowledge creation and action/application (Figure 1).

**Figure 1: Knowledge-to-action cycle**

Dobbins et al.\textsuperscript{83} conducted a RCT to evaluate the impact of three KT strategies on the incorporation of research evidence into policies and programs focused on healthy body weight promotion in a national sample of public health departments across Canada (n = 108). The chosen KT strategies are commonly used to promote evidence-based decision-making and include: (1) access to web-based resources that summarize research evidence, (2) tailored and targeted messages, which deliver relevant evidence to specific decision-makers, and (3) knowledge brokers, who work one-on-one with decision-makers to promote knowledge transfer. Tailored and targeted messages was found to be the most effective KT strategy, especially in health departments that perceived their research culture as high (i.e., placed greater value on using research evidence in decision-making). This suggests that, while tailored and targeted messages may increase the uptake of research evidence, it is important to consider organizational factors to ensure that strategies are well-suited to target users’ needs.

The poor uptake of CPGs for the management of knee OA in primary care indicates the importance of considering the needs of end-users and engaging them in the guideline development process. Tackling excessive wait times for TKA is a complex undertaking that requires the collaboration of key stakeholders (i.e., healthcare providers, patients, and hospital administrators) to achieve mutual understanding of their different perspectives and priorities. Gagliardi et al.\textsuperscript{84} describe that, in integrated KT (iKT), stakeholders are involved throughout the entire research process, from identifying the research questions to disseminating the results. The ongoing partnership among researchers, policymakers, clinicians and patients in iKT is more likely to generate knowledge that is practical and relevant to the target knowledge users. iKT is a dynamic process that is influenced by contextual factors and facilitated by establishing clear expectations from all stakeholders to avoid misunderstanding and role confusion. Thus, iKT holds considerable promise for addressing the shortcomings of current CPGs and ultimately improving the quality of care for patients with knee OA.

Finally, it is widely acknowledged that the Internet has become a central element of KT.\textsuperscript{83,85} The Internet allows health consumers to access a broad range of health-related information, from unaffiliated websites to scientific journals and online resources that compile and summarize the best available evidence on diverse health topics (e.g., MedlinePlus, DailyMed,
By enabling rapid and widespread dissemination, the Internet provides an unparalleled platform for new KT strategies to reach their target audience.

2.2.2 e-Learning

Since the 1980s, the term “e-learning” has been used to describe web-based education. In general, e-learning is an umbrella term for training and education that occurs via digital media using various instructional formats (e.g., applications, programs, websites, etc.) that enable independent, asynchronous self-study. Asynchronous e-learning can occur at any time and place and involves self-directed learning, obviating the need for a human facilitator. Asynchronous e-learning has many advantages, including easy access, flexibility, convenience, and lower costs compared to face-to-face learning. However, it also has several disadvantages, such as the need for sustained motivation to engage in self-study, lack of peer interaction, and inability to ask questions. With the power of technology and a thorough understanding of contextual factors, we can provide engaging web-based learning experiences to effectively disseminate research evidence and meet the needs of individual learners (e.g., patients and clinicians) and institutions (e.g., universities, hospitals and healthcare systems).

2.2.2.1 Continuing Medical Education

Despite the growing popularity of e-learning in medical education, research in this area is in its early stages. Few studies have evaluated the outcomes of e-learning, and existing systematic reviews focus mainly on specific medical disciplines, such as pediatrics and orthopedic surgery. A recent integrative review by Lawn et al. evaluated the available literature on e-learning for self-management support (SMS) training of healthcare professionals managing patients with chronic conditions. SMS training focuses the development of skills required for patient-centered care, including patient education and support with goal-setting, motivation and behaviour change. The authors identified 10 peer-reviewed studies (quantitative, qualitative, and mixed methods) and derived seven major themes from their findings using content analysis (Table 2). Findings revealed considerable heterogeneity in the format and features of the e-learning packages. This variation, coupled with the limited number of available studies,
indicates that the optimal e-learning methods for training healthcare professionals in the range of skills needed to manage chronic conditions remain unclear. However, all studies emphasized the importance of considering the context and providing practical, real-life examples.

**Table 2: Themes identified in a review of studies on e-learning for the training of healthcare professionals in self-management support provision to patients with chronic conditions**

<table>
<thead>
<tr>
<th>Themes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Participants and professions</td>
<td>Studies included a range of healthcare providers (nurses, GPs, GP residents, specialists, and allied health professionals).</td>
</tr>
<tr>
<td>2. Timeframe of e-learning package</td>
<td>The duration of e-learning packages varied among studies, but most consisted of multiple short sessions (20-30 minutes).</td>
</tr>
<tr>
<td>3. Content of e-learning package</td>
<td>The e-learning content varied and included a broad range of SMS capabilities (e.g., problem-solving, action planning, motivational interviewing, and goal-setting).</td>
</tr>
<tr>
<td>4. Guiding theoretical framework</td>
<td>Most studies (7 of 10) used behavioural change theories to guide the development and delivery of the e-learning package.</td>
</tr>
<tr>
<td>5. Outcome measures</td>
<td>Surveys and semi-structured interviews were most commonly used to evaluate learning and focused on short-term, subjective outcomes (e.g., patient satisfaction, intention to change practice, and perceived practice change).</td>
</tr>
<tr>
<td>6. Instructional design (e-learning features and format)</td>
<td>Various e-learning formats were used (webinar, online videos, interactive modules, and scenarios), all striving to provide an interactive and engaging learning experience that was applicable to practice.</td>
</tr>
<tr>
<td>7. Barriers to e-learning</td>
<td>All studies identified several barriers (e.g., computer literacy skills, access, time, and limited space), yet few proposed solutions.</td>
</tr>
</tbody>
</table>

One of the studies included in this integrative review was an Australian pilot study, which developed, implemented and evaluated a multidimensional learning package to improve the understanding of GP registrars or residents (GPRs) regarding their role in providing SMS and lifestyle risk modification (LRM) specifically for patients with OA. A pretraining survey
revealed a dichotomy between GPRs and their supervisors in perceptions of the importance of SMS and LRM skills, which are increasingly considered necessary for providing optimal patient care for patients with knee OA and other chronic conditions. Of the 40 GPRs, the vast majority (82.5%) considered themselves either well or very well prepared in providing SMS and LRM. On the other hand, interviews with GP supervisors (n = 13) revealed that most were unfamiliar with the core aspects of these skills and did not view them as learning priorities for GPRs. The online learning package or module was based on several health promotion principles, including structural problem-solving and action-planning, health behavior change models, and multidisciplinary learning and practice. The module divided the learning material into 3 areas using the concept of “rooms”: (1) the library room provided readings, references, websites and guidelines, (2) the consultation room contained interactive case studies where GPRs could engage in short interactions with patients (≤20 minutes) both online and in an interactive workshop, depending on GPRs’ preferred learning styles, and (3) the project room provided GPRs with three investigative approaches (patient education, practice quality improvement, and learning from patients) to further develop their understanding of SMS and LRM. The module also included self-assessment quizzes to allow GPRs to test their newly acquired knowledge. The authors found that parts of the website were not used to their full capacity, particularly the reading materials. Of all activities, GPRs most frequently accessed the quizzes, commenting on the usefulness of immediate feedback in channeling their learning. Given that only nine GPRs completed the online module, no definitive conclusions can be drawn from these preliminary findings. However, they indicate a preference for short, interactive learning activities and immediate feedback. They also further support the importance of considering the context; in this case, the discrepancy between GPRs and their supervisors in the perceived importance of the SMS and LRM skills may prevent GPRs from engaging in the e-learning program.

2.2.2.2 Multidisciplinary Chronic Care

The observed evidence-to-practice gap and clinical uncertainty in the primary care management of knee OA indicates a need for improved guidance and coordination of multidisciplinary care. The inability to adequately control pain – the predominant symptom of knee OA – is a major challenge faced by GPs and a common reason for premature referral to TKA. While knee OA is typically characterized by a transition from intermittent, acute
pain to chronic pain\textsuperscript{91,92}, it is highly variable and complex.\textsuperscript{55,93} Recent insights into the mechanisms of knee OA pain suggest that this transition involves increased sensitivity to pain (due to chronic inflammation leading to peripheral and central sensitization of the nervous system), neuropathic pain, as well as psychological and social factors (e.g., low self-efficacy, lack of social support, etc.).\textsuperscript{24,55,56,94–96} Furthermore, the interaction between comorbidities and chronic pain perpetuates a vicious cycle potentially leading to detrimental patient outcomes. For instance, anxiety, depression, and diabetic neuropathy, which shares common neuropathic processes with OA, can aggravate the perceived experience of OA pain.\textsuperscript{52,55} Given the high prevalence of comorbidities among patients with knee OA\textsuperscript{49–51}, successful management requires a holistic and multidisciplinary approach, as well as ongoing patient feedback to determine optimal pathways for the tailored delivery of core treatments (education, pharmacotherapy, nutrition counselling, physiotherapy, occupational therapy, and psychological support).

A new model of care is needed for chronic pain management that considers the psychosocial determinants of health and involves other healthcare professionals playing active roles. PTs have emerged as pivotal providers in enhancing the management of OA, particularly through ET and behavioural change programs.\textsuperscript{57,97} Furthermore, advanced practice PTs, who receive additional training to extend their scope of practice, are able to diagnose and treat patients with OA, as well as perform injections and refer them for TJA.\textsuperscript{98} Studies have shown that advanced practice PTs may provide care with equal or better effectiveness and reduce wait times for arthroplasty, while containing costs and achieving high patient satisfaction.\textsuperscript{98,99}

GPs have identified interdisciplinary collaboration and training as major needs for improved OA management.\textsuperscript{58,60,64} Interdisciplinary educational workshops have been shown to be effective for translating arthritis CPGs into practice\textsuperscript{100} and improving skills and comfort levels in administering IA joint injections.\textsuperscript{101} Although such workshops allow for the development of hands-on skills and interdisciplinary learning, they require expert instructors and a significant amount of time and resources. Information technology, however, offers a promising alternative platform for GP education that has the advantage of convenience, accessibility, and lower costs.
2.2.2.3 Computer-Based Patient Education

In conjunction with supporting GP clinical decision-making, educating patients lies at the core of the proposed NRP. Current literature focuses primarily on e-learning in continuing medical education for healthcare providers. However, the importance of patient education in improving health outcomes and reducing costs is widely acknowledged. This, coupled with GPs’ self-reported lack of time, inadequate information provision, and ineffective management of OA, calls for the development of innovative strategies to empower patients to engage in shared decision-making and play an active role in making choices related to their treatment.

There is a strong body of evidence supporting the use of patient education technologies. A Cochrane review of computer-based patient education programs for patients with chronic conditions reported improved patient knowledge, health outcomes, and feelings of self-efficacy and social support. One of the first systematic reviews to evaluate the impact of such programs concluded that it is an effective strategy for knowledge transfer and self-management skill development. Improvements in outcomes (Cohen’s d ES ≥0.5) were found in most of the identified studies (17 of 21), even among elderly patients with little computer experience. Interactive video or CD-ROM programs were the most commonly used delivery strategies. While most of the studies suggest that computer-based approaches are effective in delivering patient education, few measured patients’ long-term retention of knowledge or skills.

One of the studies included in this review focused specifically on the computer-based education of patients with OA. In this study, a multidisciplinary team consisting of two rheumatologists, a GP, a PT, a nurse practitioner (NP), a sociologist, and an educator developed eight lessons on the treatment and self-management of OA (Introduction to the Computer, Overview of the Disease, Medication, Exercise, Coping and Relaxation, Quackery, and Home Helps). A staff artist then created computer graphics and converted the text into storyboards. Participants (n = 72) field-tested the three-hour educational program and completed a questionnaire pre-test and one week post-test, which assessed the following four outcomes: (1) knowledge (using previously validated general arthritis and OA questionnaires), (2) frequency of behaviours (heat application, relaxation, exercise, rest,
massage, or swimming), (3) attitudes about the causes of OA (using multidimensional health locus of control scales\textsuperscript{107}), and (4) satisfaction with the lessons.

Statistically significant outcomes included increased knowledge (ES 0.94) and frequency of three of the six behaviours: exercise, (ES 0.64), rest (ES 0.53), and heat application (ES 0.49).\textsuperscript{105} Most participants (>85%) reported that the lessons were easy and enjoyable, that they learned a considerable amount, and would recommend them to a friend. The authors concluded that a computer-based education program significantly increased the knowledge and motivation of older individuals with OA, who could navigate it with little need for assistance. However, there is a high risk of sampling bias given that a convenience sample was recruited through advertisements in senior home community centers and consisted of all white, and mostly female (85%) participants. Nevertheless, the findings suggest that computer-based patient education was, at the very least, feasible in 1987, suggesting that modern-day circumstances would likely facilitate the implementation and uptake of electronic platform.

Research evidence on the topic e-learning for patients with OA is sparse, and thus the optimal methods of delivering web-based education remain unknown. Further research is needed to determine what instructional formats would effectively promote KT.

\subsection{2.2.2.4 Patient Decision Aids}

A Cochrane review of RCTs (n = 115) found that PtDAs improved patients’ knowledge about treatment options and their associated risks and benefits, as well as reduced “decision conflict” (i.e., increased engagement in shared decision-making) by clarifying patients’ values and enabling them to make informed decisions.\textsuperscript{108} To guide the development, implementation and evaluation of PtDAs, the International Patient Decision Aid Standards (IPDAS) Collaboration developed a comprehensive checklist\textsuperscript{109} and instrument\textsuperscript{110} consisting of quality criteria focused on three areas:

1. Content: to evaluate whether PtDA provides structured guidance, sufficient information on options and outcome probabilities, and adequate methods for clarifying patients’ values
2. Development process: to assess methodological rigour, risk of bias, use of plain and
comprehensible language (Internet-based PtDAs must meet additional criteria)

(3) Effectiveness: to determine whether PtDA improves decision quality (i.e., ensures patients’ decision-making is informed and consistent with their values and goals)

Stacey et al.\textsuperscript{111} conducted a pilot RCT to evaluate the feasibility and potential effectiveness of a PtDA for patients considering TKA in improving knowledge and decision quality. Patients with knee OA (n = 340) were recruited from an orthopedic intake clinic in a tertiary hospital in Eastern Ontario. A sports medicine specialist pre-screened new referrals for surgical eligibility using the seven-item Western Wait List Hip Knee Priority Tool\textsuperscript{112} (WWL-HKPT), mapping them onto three criteria for TKA (moderate to severe pain, moderate to severe functional limitations, and abnormal radiographic findings). Almost half of the patients (47%) were assessed to have milder OA and referred back to their GP with recommendations for conservative treatment. This is similar to the proportion of inappropriate referrals previously found at our center\textsuperscript{28} and consistent with other studies.\textsuperscript{26,113}

The remaining patients were randomized to the PtDA intervention or usual education group (n = 71/group). The PtDA consisted of a 50-minute video and a booklet with information on different treatment options (lifestyle changes, pain medications, injections, complementary therapies, and surgery). Risk and benefit probabilities and video-clips of patients’ testimonials were provided for each treatment option. The PtDA met most of the IPDAS criteria for content (12 of 15), development process (8 of 9), and effectiveness (1 of 2).

Surgeons received a one-page preference report for each patient that combined the questionnaire’s results with the clinical assessment findings. Patients in the usual education group received a standard information booklet created by the participating hospital for all patients undergoing TJA, which included information on preparing for TJA, recovery, and discharge (no information on the risks and benefits of surgery or other treatment options was provided). Subsequently, surgeons received a half-page summary of the patient’s clinical assessment findings. Outcomes were measured using a user-friendly questionnaire based on the IPDAS, which evaluated knowledge, values, preferred treatment choice, and decisional conflict. Knowledge was measured using four multiple choice questions from the Hip-Knee OA Decision Quality Instrument (OA progress over time, need for revision TKA, proportion of patients with reduced pain, and length of recovery).\textsuperscript{114} Decision quality was deemed adequate if a patient scored $\geq 66\%$ on the knowledge test (the threshold score of 66% was
chosen based on previous trials of PtDAs). Decisional conflict was measured using a four-item version of the SURE tool, which assessed whether patients felt sure about the best choice, knew the risks and benefits of each choice, were clear about what risks and benefits mattered most, and had enough support and advice to make an informed decision. At two weeks, PtDA recipients had significantly higher knowledge (71% vs. 47% of controls; \( p < 0.0001 \)) and decision quality (56.4% vs. 25.0%; \( p < 0.001 \)) regarding treatment options. At the end of the one-year follow-up period, 13% of participants were still on the waiting list. The difference between groups in the proportion of patients who underwent surgery was not significant (9.1%, 95% CI -5.3% – 23.5%; \( p = 0.2165 \)). While the preliminary findings suggest that PtDAs are promising tools for improving patient knowledge and decision quality, this study included only those patients deemed eligible for surgical consultation by a sports medicine specialist. Given that the PtDA provided information on nonoperative treatment options, it may have been more appropriate to recruit all patients rather than only those with greater OA severity.

Following this pilot trial, Stacey et al.\textsuperscript{116} conducted a RCT to evaluate the effectiveness of PtDAs compared to usual education on timely and appropriate access to TJA among patients with both hip and knee OA. Patients were recruited from two orthopedic screening clinics: an academic teaching hospital and a large community hospital. Similar to the pilot trial, patients were pre-screened by either a sports medicine specialist (at the academic site) or by an advanced practice PT or NP (at the community cite) using the WWL-HKPT. Patients deemed appropriate surgical candidates (343 of 956; 36%) were referred to an orthopedic surgeon and randomized to the PtDA intervention (n = 174) or the usual education control (n = 169). The primary outcome was the average wait time between screening and initial surgical consultation. Secondary outcomes included decision quality, decisional conflict, realistic expectations of outcomes, and surgery rates within two years. The PtDA intervention was associated with shorter wait times (hazard ratio 1.25, 95% CI 0.99 – 1.60; \( p = 0.0653 \)). The median wait time was three weeks shorter among PtDA recipients in the community clinic, but there was no difference at the academic site. More patients in the intervention group achieved good decision quality (56% vs. 45% of controls, relative risk [RR] 1.25, 96% CI 1.00 – 1.56; \( p = 0.050 \)), and fewer underwent surgery within two years (73% vs. 81%; RR 0.91, 95% CI 0.81 – 1.03; \( p = 0.121 \)). Although the PtDA intervention was associated with
improved knowledge and decision quality, as well as fewer patients electing to undergo surgery and shorter wait times at the community hospital clinic, the overall effect was not statistically significant.

Given the discrepancies in the findings between the two surgical screening clinics, Boland et al.\textsuperscript{117} conducted a subgroup analysis of knee OA patients from this RCT (n = 242), positing that different pre-surgical assessment approaches may have influenced outcomes. At the academic teaching hospital, a sports medicine specialist conducted a 15- to 20-minute pre-surgical evaluation, compared to a 45- to 60-minute assessment by an advanced practice PT or NP at the community hospital site. To better understand the optimal circumstances for PtDA use, the authors compared the effects of the intervention on decision quality, decisional conflict, surgery rates and wait times between the two sites. At two weeks, PtDA recipients were more likely to make better quality decisions than controls at the academic site (54% vs. 35%; RR 1.53, 95% CI 1.00 – 2.33; p = 0.044), whereas there was no difference between groups at the community site (47% vs. 51%; RR 0.93, 95% CI 0.64 – 1.86; p = 0.71). Fewer PtDA recipients at the academic site experienced decisional conflict (13% vs. 23%; RR 0.62, 95% CI 0.43 – 1.00; p = 0.05), while the opposite was observed in the community clinic, where more PtDA users experienced decisional conflict (40% vs. 24%; RR 1.68, 95% CI 0.95 – 2.96; p = 0.08). There was no significant difference between the two sites in the effect of the intervention on two-year surgery rates or wait times. Given that the intervention was associated with improved decision quality and reduced decisional conflict at the academic site but not at the community clinic, PtDAs appear to be more useful when extensive pre-surgical evaluation and counselling are unavailable or unfeasible.

By improving patients' knowledge and expectations prior to surgical consultation, PtDAs have the potential to reduce the demand for TKA by preventing the over-referral of patients who are unwilling undergo surgery. Such decision support tools may be particularly useful in settings where the length of pre-surgical evaluation is limited.
2.2.3 Wait Time Management Strategies

Although the federal ministry of health identified reducing wait times for TJA as a key priority and developed wait time benchmarks, no strategy had been proposed at the national level. As a result, provinces have piloted and implemented a variety of WTMS, such as presurgical screening and prioritization tools and central intake systems. Given that current studies focus predominantly on the development and implementation of different strategies, little is known about their sustainability and long-term implications.

Pomey et al. described five different WTMS that have been implemented across Canada and identified the contextual and organizational factors affecting their success and sustainability using a conceptual model. This model encompasses four dimensions that can impact the success of WTMS at both local and systemic levels: governance, culture, resources, and methods/tools. The authors found that the following factors were essential for a sustainable WTMS: financial incentives, strong leadership, collaboration between managers and clinicians, consideration of the entire continuum of care, and an organizational culture that cultivates innovation.

2.2.3.1 Central Intake and Assessment Clinics

In 2004, the Ministry of Health and Long-Term Care (MOHLTC) announced its new agenda to transform Ontario’s healthcare system to ensure sustainability and improve access to care. Subsequently, 14 Local Health Integration Networks (LHINs) have been created across the province to manage the integration and delivery of health care services at the local level. As part of the ministry’s agenda, LHINs have been mandated to develop central intake and assessment clinics (CIACs) to coordinate and streamline the referral process using centralized triage and/or pooled wait lists. CIACs allow referring clinicians to send referral requests to one central location rather than to specific surgeons, where allied health professionals screen and triage referrals based on a standardized process.
While CIACs may reduce unnecessary referrals, they create an additional, costly point of contact between primary and specialty care. Furthermore, the 2014 CMA Policy Statement argues that there is no single optimal method to improve access specialty care, and that a combination of strategies should be implemented (e.g., standardized referral pathways, CIACs, physician directories. Thus, the NRP may serve as an adjunct to CIACs to reduce wait times for surgical consultation by educating GPs on appropriate and timely referral to TKA.

2.2.3.2 Single-Entry Model of Referral

Damani et al. described insights from the implementation of the Winnipeg Central Intake Service (WCIS) – a single-entry model of referral to reduce wait times for TJA in Manitoba. Single-entry models are WTMS that aim to streamline the referral process and patient flow by pooling waiting lists, providing services through a centralized access point, and referring patients to the next available surgeon. The key features of the WCIS included standardization (of the referral form, pre-consultation patient questionnaire, screening criteria, and rules for surgeon participation and referral allocation), an electronic waitlist tracking tool, patient education prior to surgical consultation (via pamphlets, booklets, online videos, and in-person classes), and monitoring of surgical performance and patient outcomes.

All members of the WCIS project team (n = 13) participated in semi-structured interviews during and one year after its implementation and described the successes, barriers and unexpected consequences. Overall, the team felt that the four pre-specified implementation objectives were met: (1) the WCIS centralized the referral process, (2) approximately half of the patients were referred to the next available surgeon, (3) screening and allocation of referrals based on surgical capacity reduced the variation in wait times between surgeons, and (4) the electronic waitlist tracking tool improved the accuracy of measuring referral volumes and wait times. Despite the initial poor uptake and mistrust among GPs and orthopedic surgeons, the authors reported that weekly one-on-one communication promoted their understanding and cooperation. Despite this, some GPs and surgeons continued to use their former referral systems. Overall, simplified referral request forms and clearly defined screening criteria appeared to reduce the number of inappropriate referrals and wait times for surgical consultation. The authors emphasized that early involvement and ongoing, transparent communication with key stakeholders is imperative for trust and cooperation.
Despite promising results, this case study lacks quantitative outcome measures and draws conclusions based on a single initiative and the experiences of a small project team, thereby providing limited evidence to support this referral model. Furthermore, the WCIS was evaluated through a narrow lens, without considering the perspectives of key stakeholders (i.e., GPs, surgeons, and patients). Nevertheless, the authors’ detailed description of the design and implementation process may provide valuable guidance for future WTMS.

### 2.2.4 e-Referral Systems

While limited research has been done on the effectiveness of e-referral in reducing the demand for TKA, some qualitative studies have explored patient satisfaction with the e-referral process and identified factors that influenced the implementation of various e-referral systems.

In 2013, the Health Quality Council of Alberta published a study on the continuity of patient care, in which it strongly recommended the development of a single provincial e-referral system to standardize the workflow of all specialty services. The proposed system would allow referring physicians to submit referral requests, track referral status, receive post-consultation specialist reports, and view the estimated wait times for consultations, tests and procedures. In addition, a separate portal would enable patients to receive notifications about their referral status and scheduled appointments, find appropriate contact information in case of a problem, and view their lab results, imaging and procedure reports, and hospital discharge summaries. Following this recommendation, several e-referral systems have been proposed or piloted in Alberta. In 2016, the Health Quality Council of Alberta initiated a project to elicit patient perspectives on the e-referral process and understand how it impacts patient care. Using purposive sampling, the authors recruited patients of different ages and backgrounds (n = 35) to participate in five focus groups. A constant comparative analysis of the focus groups revealed many similarities in participants’ perspectives and experiences that were grouped into five main themes (Table 3).
### Table 3: Patient perspectives on e-referral systems in Alberta

<table>
<thead>
<tr>
<th>Theme</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Overall experience with the referral process</td>
<td>Many participants criticized the lack of information and communication at various stages of the referral process. Common problems included referrals being sent to the wrong specialist and urgent referrals not being treated as such. A few positive experiences were also reported (e.g., wait times being shorter than expected).</td>
</tr>
<tr>
<td>2. The ideal e-referral system</td>
<td>When asked to describe the ideal e-referral system, participants across groups identified many similar key elements (Table 4) and emphasized the importance of patient feedback throughout its development and implementation.</td>
</tr>
<tr>
<td>3. Important information throughout the referral process</td>
<td>Receiving the following information was most commonly rated as “very important”: whom to contact in case of a problem, expected wait times for appointments, the results of consultations/tests/procedures, and how to prepare for consultations/procedures.</td>
</tr>
<tr>
<td>4. Benefits, concerns, and communication preferences</td>
<td>All participants, even those without online access, felt that the benefits of an e-referral system far outweigh any drawbacks. Despite overall support, two key concerns were voiced: (1) system security and privacy of health information, and (2) availability of other communication options (especially for patients without electronic devices). All but one participants preferred to receive communication via email or text messaging (one preferred phone calls or postal mail).</td>
</tr>
<tr>
<td>5. Online access to referral status and information</td>
<td>Participants widely supported having online access to track their referral status and view relevant health information. Some felt this would empower patients and allow them to become more involved in their care.</td>
</tr>
</tbody>
</table>
Table 4: Characteristics of an ideal e-referral system

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>User-friendly layout</td>
<td>The system should be robust and easy to navigate.</td>
</tr>
<tr>
<td>Transparency</td>
<td>Patients should be informed about expected wait times and their referral status at all times and have access to a “paper trail” that can be printed.</td>
</tr>
<tr>
<td>Adequate information</td>
<td>Patients should know whom to contact for follow-up or in case of a problem, be informed about their appointment dates promptly, and receive instructions on how to prepare for consultations, tests and procedures.</td>
</tr>
<tr>
<td>Bidirectional communication</td>
<td>Patients should be able to indicate that they have received and understand the information provided.</td>
</tr>
<tr>
<td>Fairness</td>
<td>Urgent referrals should be prioritized.</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Patients should be able to change appointment dates, have some say in where they are referred, and be notified about opportunities for earlier appointments.</td>
</tr>
<tr>
<td>Central repository of information</td>
<td>Patients should have online access to test results as soon as they are available and be able to share personal health information with new physicians.</td>
</tr>
</tbody>
</table>

The findings from this cross-section of patients in Alberta suggest that, although e-referral systems are highly supported, there is much room for improvement. According to the participants, an ideal e-referral system is transparent and fair, allows for clear communication, and provides access to information at all stages of the referral process. Given the small sample size, these results are preliminary and require further validation. However, they provide insights into patient perspectives on e-referral that are useful for guiding the development of our NRP.

In the US, Delphine et al. interviewed the leaders of diverse healthcare organizations to identify the drivers, barriers, facilitators, and evaluation methods of e-referral and/or consultation systems. Participants (n = 16) were recruited using a limited snowball sampling approach and represented a range of organizations at different stages of system implementation, including academic medical centers, health plans, public healthcare delivery systems, and community health networks. The authors specified that an e-referral implies an
expectation that the specialist will see a patient, while an e-consultation does not. Although both allow for pre-consultation communication between specialists and referring providers, only e-consultation systems encourage ongoing, electronic co-management of patients. Integrated e-referral and consultation systems combine the two and do not require the referring provider to distinguish referral requests from consultations. For the purposes of our study, we will only focus on the e-referral (n = 5) and integrated systems (n = 5) given their relevance to our proposed NRP. In the participating organizations, both types of systems allowed referring GPs and clinic coordinators to track referrals and were either integrated into the electronic medical record or used standalone platforms. GPs submitted referral requests using a free text form or a structured template with embedded referral guidelines. In the e-referral systems, administrative assistants reviewed referral requests and allocated them to appropriate specialists, whereas in the integrated systems, GPs submitted referral requests to designated specialists, who determined whether patients should be seen in person or could be managed by e-consultation alone.

Participants cited different barriers, facilitators and reasons for implementing e-referral vs. integrated systems. E-referral systems were primarily implemented to enhance functional and tracking efficiency, whereas the main drivers of integrated systems were poor inter-provider communication and access to specialty care. The main factors contributing to the uptake of e-referral systems were engaged leadership of high-level executives (e.g., Chief Medical Officers) and physician champions, while provider incentives and user-friendly platforms were the main facilitators of integrated systems. Participants identified that GP resistance to change was the main barrier to implementation. From the outset, all systems evaluated the volume of referrals, number and type of specialty services available, number of referring primary care sites and providers, and time from referral to consultation. Overall, a consistent finding across organizations was that the successful uptake of all systems required funding, provider incentives, as well as executive and physician leadership. Given that the leaders of diverse organizations at different stages of system implementation reported similar drivers, barriers and facilitators, these findings are likely relevant to many healthcare contexts.

Despite the increasing implementation of e-referral systems, research in this field is in its early stages. The existing qualitative literature suggests that e-referral systems hold great promise for streamlining the referral process and reducing wait times for specialty care.
Future studies should consider the perspectives of the end-users (i.e., GPs and orthopedic surgeons).

### 2.2.4.1 Electronic Order Entry Systems

Studies suggest that electronic order entry systems can effectively address the issue of unnecessary ordering of MRI for the diagnosis of OA. These systems include features such as structured templates and automated feedback to support the decision-making of ordering providers. Khorasani et al.\(^{124}\) identified several potential benefits of electronic order entry systems, including improved efficiency, selection of appropriate diagnostic imaging tests and quality of care, as well as reduced healthcare costs. One study showed that an electronic order entry system increased the appropriateness of imaging tests ordered by GPs by 25%.\(^{125}\) The findings of a systematic review further support the potential of electronic order entry systems to significantly enhance the efficiency and effectiveness of imaging services.\(^{126}\)

Consistent with other implementation research studies, this review reiterates the importance of considering the circumstances of individual organizations that may facilitate or impede their uptake and impact. Electronic order entry can be integrated into e-referral systems to further improve efficiency and contain costs.

### 2.2.5 Proposed New e-Referral Pathway

The reviewed literature will inform the development and implementation of a NRP for patients referred for surgical consideration of TKA. The fundamental goal of the NRP is to serve as a guided e-referral system that facilitates shared decision-making regarding appropriate and timely referral to orthopedic specialty care. Based on the theoretical underpinnings of KT, the NRP will synthesize guideline recommendations, systematic reviews and multidisciplinary expertise to provide relevant information to patients and referring GPs within the local context.

Previous successful WTMS across Canada have demonstrated the importance of involving key stakeholders (i.e., GPs, surgeons and patients) throughout the implementation process to facilitate uptake and compliance.\(^{118}\) At the initial stages of designing the study, we engaged various healthcare providers (i.e., GPs, orthopedic surgeons, sports medicine specialists, and PTs) through brainstorming meetings to identify patient factors related to appropriateness for...
TKA. Afterward, a panel of orthopedic surgeons rated the most important outcomes of surgical suitability using an informal modified Delphi consensus approach. These results were then discussed at clinical research rounds until further consensus was reached. Subsequently, we developed and validated a multivariable predictive model that is able to identify the vast majority of surgical candidates (>90%), thereby reducing the proportion of inappropriate referrals.\textsuperscript{27,28} To bypass the need for clinician involvement or interpretation, all predictors included in the model are patient-reported. This model will lay the groundwork for the NRP’s educational component, which will include information on conservative management options, the roles of local healthcare professionals (e.g., PTs, occupational therapists, sports medicine specialists, GPs who administer joint injections, etc.) and how to access their services, appropriate diagnostic imaging tests, TKA and its associated outcomes, as well as clear indication criteria for surgery. Furthermore, referring GPs would likely benefit from having access to a physician directory, which provides a list of orthopedic surgeons, their areas of specialization and projected wait times.\textsuperscript{77}

Based on the findings from the reviewed literature, we designed a conceptual model of the NRP that reflects a holistic approach and depicts its key features, relevant stakeholders, and intended outcomes (Figure 2). Achieving the NRP’s success and sustainability will require an ongoing, cyclical process resembling the knowledge-to-action cycle (depicted in Figure 1)\textsuperscript{82}, which involves adapting the knowledge to the local context, considering barriers to knowledge uptake, tailoring the content and delivery strategy, monitoring use, and evaluating outcomes through feedback from the end-users (i.e., patients and referring GPs). For optimal uptake, it is important to provide end-users with an explanation of the NRP’s purpose and potential benefits. From a patient perspective, the online system may be cost-saving by avoiding the need for out-of-pocket expenses (e.g., for transportation, accommodation, patient and caregiver time off from paid work, etc.). Furthermore, it would promote patient autonomy by providing a private, self-paced learning environment that is accessible from home and simulates real-life experiences.\textsuperscript{105} From a healthcare system perspective, the NRP may expedite wait times for TKA by reducing the proportion of nonsurgical referrals and redirecting them to alternative management options and providers, as well as decrease costs associated with unnecessary imaging tests and surgical consultations. Furthermore, to disseminate knowledge effectively, the NRP should adopt a user-friendly, tailored approach
that delivers relevant information in a clear and comprehensible manner, while considering individual differences (e.g., in age, gender, ethnicity, values, learning preferences, and visual deficits that may occur with age).
Modern information technologies offer innovative approaches for knowledge mobilization. Whiteboard videos may effectively convey complex health information by providing an engaging and interactive learning experience.\textsuperscript{127,128} Furthermore, incorporating whiteboard videos into the NRP would allow us to gain a better understanding of how patients and GPs process and act on information by evaluating the impact of this new KT strategy on knowledge acquisition and behaviour change. Dissemination strategies could take advantage of existing social networking services. Finally, ongoing monitoring and evaluation of all aspects of the NRP are essential for quality improvement. By addressing the issues of unnecessary referrals and inefficiency of the current referral system, the NRP may ultimately reduce wait times for TKA. Future studies will assess the cost-effectiveness of this referral pathway and identify the factors that influence its uptake.

\textbf{Figure 2: Key features, relevant stakeholders and intended outcomes of the NRP}
2.3 Summary

Despite recent efforts to improve access to specialty care, wait times for TKA continue to exceed the clinically acceptable benchmark. The rising demand for TKA, coupled with the economic burden and detrimental health outcomes of excessive wait times, calls for the development of new models of care. By providing the first point of contact, GPs play a central role in the diagnosis and conservative management of knee OA, as well as in the judicious selection of patients who may benefit from surgery. The issues of unwarranted ordering of MRI scans, inadequate conservative management, and high rate of inappropriate referrals indicate a need for innovative approaches to support consistent clinical decision-making in primary care.

We proposed a NRP as a strategy to reduce wait times for TKA by standardizing the referral process and providing guidance for patients and referring physicians. The NRP will integrate evidence-based recommendations with patient-reported predictors of surgical appropriateness to provide education on appropriate imaging tests, conservative management, indications for TKA and the risks and benefits of surgery, thereby promoting appropriate and timely referral. Research on the topics of e-learning and e-referral is in its early stages, and thus the optimal implementation methods remain unknown. We therefore designed a conceptual model of the NRP, which was underpinned by KT theories and informed by the available evidence, that involves key stakeholders and considers contextual factors that may influence uptake and sustainability. Future studies will determine the cost-effectiveness of the NRP and identify strategies to promote user engagement and improve the quality of care.
Chapter 3

3 Objectives

We proposed a NRP as a strategy to reduce the proportion of inappropriate referrals and decrease healthcare costs associated with unnecessary diagnostic imaging tests and surgical consultations. The goal of the NRP is to support shared decision-making and promote appropriate and timely referral to TKA, thereby improving access to specialty care for patients who are sufficiently symptomatic, have exhausted conservative treatments, and are willing to undergo surgery. A future, larger scale investigation will determine the cost-effectiveness of the NRP compared to usual care.

The primary objective of this study was to measure healthcare resource use (i.e., conservative treatments and diagnostic imaging tests), costs, and HRQoL in patients with knee OA at five different stages along the continuum of usual care:

(1) Prior to referral,

(2) From referral to initial surgical consultation (WT1),

(3) From date of inclusion on surgical wait list to TKA (WT2) or, if not scheduled for surgery, from initial consultation to one-year post-consultation

(4) From TKA until two years postoperative, and

(5) Approximately five years post-consultation.

The secondary objectives of this study were to determine the proportion and determinants of inappropriate referrals, as well as to estimate WT1 and WT2.

The comparison of these outcomes before and after the implementation of the NRP will enable us to evaluate its potential to promote the uptake of evidence-based recommendations into primary care practice and ultimately reduce wait times for TKA.
Chapter 4

4 Methods

This single-center prospective cohort study was conducted between December 2016 and April 2018 in London, Ontario. Patients with knee OA were recruited at different stages along the continuum of care and completed a series of questionnaires at the time of recruitment (Appendix C). Participants were followed for a minimum of one-year post-consultation to a maximum of two years postoperative. Following initial consultation, the attending surgeon completed a form outlining whether the patient was scheduled for surgery (Appendix D). The institutional Health Sciences Research Ethics Board at the University of Western Ontario granted approval for this study (Appendix A).

4.1 Eligibility Criteria

Patients over the age of 18 diagnosed with knee OA and referred to an orthopedic surgeon for consideration of TKA were eligible for this study. Patients were excluded if they were unable to complete the questionnaires in English or mentally unable to provide informed consent. The study population consisted of four patient groups recruited at different stages of care: (1) at the time of referral to an orthopedic surgeon (new referrals), (2) at their initial surgical consultation (new consults), (3) at their pre-admission appointment prior to undergoing TKA (pre-surgical patients), or (4) at approximately five years post-consultation (long-term follow-up patients).

4.2 Participant Recruitment and Follow Up

Consenting patients were registered into a secure online data management system (EmPower Health Research Inc.; www.empowerhealthresearch.ca) and completed a series of questionnaires at the time of recruitment, either on paper or electronically using an iPad (Model MD786CL/B, © Apple Inc.). Upon completion of paper questionnaires, the study coordinator transcribed the data into the online system. Follow-up assessments were conducted either electronically or over the phone. Patients who chose to participate online were assigned a unique username and password to access the data management system.
In addition to the automatic reminder emails sent by the system, the study coordinator sent individualized emails to each participant prior to their follow-up assessment to provide detailed instructions on how to sign in to the online system. To facilitate questionnaire completion and maximize retention, the questionnaires were also attached to the email as a fillable PDF document in the case of problems signing in. The remaining patients were contacted by telephone or postal mail to obtain their responses to the questionnaires. Methods of recruitment and follow-up assessments differed for each of the four patient groups and are described below (Figure 2).

4.2.1 New Referrals

The study coordinator identified patients with knee OA who were referred to an orthopedic surgeon and invited them to participate in the study via telephone shortly after their referral. Patients who agreed to participate provided consent electronically or verbally over the phone. New referrals completed the questionnaires at the time of referral and then on a weekly basis until their surgical consultation (Figure 2).

4.2.2 New Consults

The study coordinator screened new consults for eligibility prior to their initial surgical consultation. New consults were approached for recruitment in the joint replacement clinic prior to their appointment. Following consultation, patients were either deemed appropriate referrals and scheduled for TKA or inappropriate referrals and not booked for surgery. Appropriate referrals completed follow-up assessments every three months until two years postoperatively, whereas inappropriate referrals were followed for one year post-consultation (Figure 2).

4.2.3 Pre-Surgical Patients

The study coordinator screened pre-surgical patients for eligibility prior to their pre-admission appointment before TKA. Consenting patients completed the questionnaires during their pre-admission appointment and then at 1.5 months, six months, and subsequently every three months until two years postoperatively (Figure 2).
4.2.4 Long-Term Follow-Up Patients

This group consisted of patients who were deemed inappropriate referrals in a previous study that was conducted in 2013. The study coordinator contacted patients by telephone to remind them about the study. Participants had been registered in the database in the previous study and could choose to complete questionnaires online or over the phone. Completion of the questionnaires concluded their participation in the study (Figure 2).

Patients were recruited at different stages along the continuum of care:

<table>
<thead>
<tr>
<th>Referral</th>
<th>Initial consultation</th>
<th>Pre-admission appointment before TKA</th>
<th>~5 years post-initial consultation</th>
</tr>
</thead>
</table>

**Figure 3: Outcome measures and follow-up frequencies for the four patient groups**
4.3 Outcome Measures

4.3.1 Patient Demographics

Upon recruitment, participants completed a demographics form and reported their age, sex, height and weight (to calculate BMI), affected knee, unilateral/bilateral symptoms, previous TJA, living arrangements, presence/absence of stairs at home, and global assessment of knee pain. Global assessment of pain was measured by asking, “Considering all of the ways in which knee pain and arthritis affect you, how are you doing today?” and recorded on a visual analogue scale (VAS) ranging from 0 (very well) to 10 (very poorly). In addition, new referrals and new consults reported their willingness to undergo surgery and Patient Acceptable Symptom State 2 (PASS 2). Willingness to undergo surgery was measured using a five-point Likert-type scale. We considered participants willing to undergo TKA if they were “definitely willing” or “probably willing”. If participants were “unsure”, “probably unwilling”, or “definitely unwilling”, they were deemed unwilling to undergo surgery and asked to provide an explanation. PASS 2 is defined as the symptom threshold beyond which patients no longer consider themselves well. Patients were asked to consider all the ways in which knee pain and arthritis affect them, and whether they would be satisfied if they remained in their current state for the next few months (yes/no).

4.3.2 Healthcare Resource Use

Upon recruitment, participants completed a questionnaire that captured the use of diagnostic imaging tests and conservative treatments for knee OA, either prior to referral (for new referrals and new consults) or following initial consultation (for pre-surgical and long-term follow-up patients).

Patients reported their use of allied health services, including physiotherapy, chiropractic therapy, and occupational therapy (yes; no, it was not recommended; or no, but it was recommended). If participants responded “yes”, they were asked to specify the treatments used (e.g., exercises, ice, heat, TENS, laser, etc.), the duration and frequency of therapy, their level of compliance with the program (perfect compliance, 75%, 50%, 25%, or non-compliant), and whether they discontinued therapy sooner than recommended. If patients
reported that they were 25% compliant or non-compliant, or if they stopped attending therapy sooner than recommended, they were asked to select one or more reasons from a list of social, environmental, and psychological factors. Patients who reported that they had not pursued therapy despite it being recommended were asked to provide an explanation.

In addition, we captured previous use of IA injections (corticosteroid, HA, or other) and services provided by massage therapists, osteopaths, acupuncturists, or pedorthists/orthotists. Patients also reported whether they had tried any of the following conservative treatments: exercise (aerobic, resistance, stretching, or other), weight loss, topical NSAIDs, knee bracing, specialized footwear (e.g. insoles or orthotics), gait aids, and prescription or over-the-counter medications.

Furthermore, we asked patients to report diagnostic imaging tests ordered by their referring provider (x-ray, MRI, MRI arthrogram, CT, or ultrasound) and, if known, the results (mild/moderate OA or severe OA). The purpose of this was twofold. Firstly, we wanted to estimate the use of unnecessary imaging (e.g., MRI for the diagnosis of OA). Secondly, we sought to determine the proportion of patients who were aware of their test results and could therefore self-report this information in the NRP, thereby improving referral efficiency.

Finally, given that long-term follow-up patients were not scheduled for TKA at their initial surgical consultation in 2013, we wanted to determine if they had undergone surgery thereafter, if surgery was recommended but they opted out (if so, why), or if they were scheduled for surgery at the time of data collection. Those who had undergone surgery were asked to specify the surgical procedure(s) (i.e., meniscal repair, meniscal debridement, meniscal excision, high tibial osteotomy, anterior cruciate ligament reconstruction, microfracturing of bone cartilage, implant insertion to repair a hole in bone cartilage, and/or other).

**4.3.3 Health-Related Quality of Life**

HRQoL was evaluated at the time of recruitment and at each follow-up using the WOMAC, a disease-specific health status tool, and two measures of generic HRQoL: the 12-Item Short Form Health Survey (SF-12; version 2) and the EuroQoL Five Dimensions Five-Level (EQ-5D-5L) instrument. The WOMAC is a 24-item questionnaire that consists of three subscales: pain (five items), stiffness (two items), and physical function (17 items). Questions are
scored on a scale from 0 (none) to 4 (extreme) and then weighted and summed for each subscale or totaled for an overall index. The WOMAC is extensively used to measure health status among patients with hip and knee OA and has been widely reported to be valid, reliable and responsive.\textsuperscript{131–133}

The SF-12 (version 2) contains 12 questions that measure eight domains: general health, bodily pain, physical functioning, role limitations due to physical health problems, vitality, social functioning, mental health, and role limitations due to emotional problems. Questions are weighted and summed to obtain two summary measures: a physical component score (PCS) and a mental component score (MCS). The PCS and MCS range from 0 (worst health state) to 100 (best health state). The SF-12 is a valid and reliable instrument for assessing health status in the general population and has been shown to be the most valid and responsive generic HRQoL tool for patients undergoing TJA.\textsuperscript{133,134} Marsh et al.\textsuperscript{135} reported excellent inter-rater reliability between electronic and paper versions of the WOMAC and SF-12 in patients following TJA.

Finally, the EQ-5D-5L consists of two components: a descriptive system and VAS evaluation. The descriptive system contains five items or dimensions – mobility, self-care, usual activities, pain/discomfort, and anxiety/depression – each scored on a five-point Likert-type scale. The scores can then be converted into a utility value from 0 (death) to 1 (perfect health). This is particularly useful for economic evaluations that measure disease burden in quality-adjusted life years, which are calculated by multiplying the utility value by the amount of time spent in that health state. The second component measures patient-perceived health state using a VAS ranging from 0 (the worst health you can imagine) to 100 (the best health you can imagine). In patients referred for TJA, the EQ-5D-5L appears to have moderate reliability and higher validity than the original three-level questionnaire (EQ-5D-3L).\textsuperscript{136}
4.3.4 Costs

To better understand the current clinical pathway for knee OA, we established a standardized costing framework and captured a wide range of costs along the continuum of care (from the time of referral until two years post-operatively) from the healthcare payer (MOHLTC), patient/private insurer, and societal perspectives. While the healthcare payer perspective includes only the direct medical costs associated with OA (i.e., imaging tests, procedures, provider time, hospitalizations and medications for patients over the age of 65 or with disabilities), the societal perspective also accounts for out-of-pocket costs (e.g., transportation, parking, etc.) and productivity losses. Thus, the societal perspective captures both the direct and indirect costs of knee OA incurred by patients, their caregivers, private insurance companies, and the healthcare system.

Our costing approach consisted of two main steps: (1) quantifying the consumption of healthcare resources on an individual patient level and (2) valuating each unit used. The quantity of resources consumed is then multiplied by the unit cost to obtain the total cost per patient.

4.3.4.1 Quantifying Healthcare Resource Use

Participants completed the 19-item cost questionnaires at the time of recruitment and at each follow-up assessment. We measured the following direct costs associated with OA: GP and specialist visits, inpatient hospital admissions, emergency room visits, allied health services, diagnostic imaging tests, procedures, assistive devices, prescription and over-the-counter medications, and any other relevant expenses. To capture indirect costs, we asked participants to report their employment status and time lost from paid work, volunteering, and homemaking activities (in days or hours). In addition, patients indicated whether they received assistance from a spouse, relative or friend, the number of hours of assistance per week (with healthcare, personal care, household chores, transportation, etc.), and whether their caregiver was required to take time off from work. To facilitate questionnaire completion, the online database saved participants’ medications and employment information from the previous assessment, allowing for updates to be made in the case of a change.
4.3.4.2 Valuating Resource Use

We used multiple data sources to obtain unit costs for each healthcare resource and estimate the total mean cost per patient over the continuum of care. Costs of physician visits, diagnostic tests, and medical procedures were obtained from the Ontario Health Insurance Schedule of Benefits and Fees (effective March 1, 2016). The costs of allied health services were calculated based on the hourly rates reported by the corresponding regulatory agencies. The Patient Cost Estimator tool developed by the Canadian Institute for Health Information provided hospital admission and surgery costs (derived using the case-mix group methodology).\textsuperscript{137} This costing methodology aggregates inpatients with similar characteristics, thereby providing precise estimates for most cases.\textsuperscript{138}

We obtained the unit costs of medications from the Ontario Drug Benefit Formulary (effective April 30, 2018)\textsuperscript{139} and added the applicable markup costs and dispensing fees. The total cost per drug was calculated based on drug accessibility (prescription vs. over-the-counter) and individual patient’s coverage (Ontario Drug Benefit plan vs. private insurance vs. out-of-pocket) (Appendix E).

Finally, we estimated productivity costs using the human capital approach. Time lost from paid work was valued at the average hourly wage in Ontario reported by Statistics Canada.\textsuperscript{140} Informal caregiver assistance and time lost from volunteer and homemaking activities were valued at the current minimum wage in Ontario (effective January 1, 2018).\textsuperscript{141} All costs were adjusted to 2018 Canadian dollars.

4.3.5 Surgical Consultation Form

After seeing new consults, the attending surgeon completed a surgical consultation form developed and refined by Churchill et al.\textsuperscript{129} and Malian et al.\textsuperscript{28} Surgeons classified patients as appropriate or inappropriate candidates for TKA based on their radiographs and indicated whether they had ordered x-rays for each consultation (provided that existing x-rays were inadequate or unavailable).

Patients deemed appropriate surgical candidates were assigned to one of three priority ratings:
Priority rating 1: The consult should have occurred sooner (late referral).

Priority rating 2: The consult occurred at the appropriate time (timely referral).

Priority rating 3: The consult could have waited (early referral).

If timely referrals were not scheduled for surgery, surgeons specified a reason (e.g., patient was unwilling to undergo surgery or had too many comorbidities). Surgeons also provided an explanation for assigning priority rating 1 (e.g., arthritis has been advanced and symptomatic for a long time). If surgeons triaged a patient as an early referral or considered that the patient should not have been referred for TKA, they were asked to select one or more of the following reasons: OA is not advanced, insufficient symptoms, age, occupation, patient expectations, patient has not exhausted conservative treatments, patient may be more appropriate for a sports orthopedic surgeon, or other.

4.4 Estimation of Sample Size

Based on current practice and feasibility considerations, we aimed to recruit a convenience sample of 50 new referrals and a total of 300 new consults and pre-surgical patients (n = 150/group) to capture a representative sample. Long-term follow-up patients (n = 166) were recruited in a previous study.\textsuperscript{129}

4.5 Data Analysis

We tabulated demographic characteristics for each group using descriptive statistics, with means and standard deviations (SDs) for continuous variables and proportions for categorical variables.

To address our primary objective, we calculated proportions for categorical outcomes (healthcare resource use) and means ± SDs for continuous measures (costs, WOMAC, SF-12, and EQ-5D-5L and VAS) at each follow-up. The median (IQR) and range (minimum to maximum) were also added for non-normal distributions. We also plotted the trajectory of continuous outcomes over time along with 95% CIs for each patient group. The EQ-5D-5L scores were converted into utility values using the crosswalk link function developed by the EQ Group to estimate the relationship between responses to the new EQ-5D-5L and existing value sets (i.e., utility values) for the EQ-5D-3L.\textsuperscript{142} We used the United States EQ-5D-3L
value set derived from a representative sample of the general population using the time-trade-off valuation method.

To address the secondary objectives, we determined the proportion of appropriate vs. inappropriate referrals based on the surgical consultation forms and reported the reasons why patients were classified as inappropriate. We defined an inappropriate referral as any patient who was not scheduled for surgery after the initial consultation (i.e., should not have been referred to TKA, was an early referral, or was a timely referral but unwilling to undergo surgery). We calculated the median ± interquartile range (IQR) for WT1 and WT2 based on the dates of referral, initial surgical consultation, and TKA obtained through the hospital’s electronic medical record. Given that some patients in the pre-surgical group were not scheduled for surgery at their initial consultation (but rather at a follow-up consultation), we also calculated the median wait time between the initial consultation and follow-up (i.e., decision to operate), and between the follow-up consultation and TKA.

Missing items were followed-up by phone, e-mail or postal mail, if possible. Questionnaires were considered complete if they were fully complete or if the outcome measure could be adequately calculated despite missing data. Participants who completed follow-up assessments were included in the analysis.
Chapter 5

5 Results

Between December 2016 and April 2018, a total of 590 patients were screened for eligibility (Figure 4). Of these, 369 were enrolled in the study and completed the baseline questionnaires. Demographic characteristics were similar across the new referral, new consult, and pre-surgical groups (Table 5). In addition, 25 patients recruited in a previous study completed the questionnaires at their long-term follow-up. Similar to previous studies conducted in this field\textsuperscript{10,12}, a considerable proportion of participants were not available for follow-up assessments. This was predominantly due to appointment postponements/cancellations. In addition, a number of participants did not reach their next assessment by the end of the follow-up period (Figure 4).
New Referrals

Assessed for eligibility and contacted for recruitment
\((n = 166)\)

- Agreed to participate \((n = 76)\)
- Unable to contact \((n = 46)\)
- Excluded \((n = 44)\)
  - Declined to participate \((n = 31)\)
  - Not new referrals \((n = 4)\)
  - Not knee OA \((n = 1)\)
  - Non-English speaking \((n = 1)\)
  - Expected WT1 > 5 mo. \((n = 5)\)
  - Vacation \((n = 2)\)

- Withdrawn \((n = 18)\)
  - Lost to follow-up \((n = 6)\)
  - Withdrew consent \((n = 12)\)
  - Too time-consuming \((n = 3)\)
  - Consultation date postponed by several months \((n = 7)\)
  - Illness \((n = 2)\)

Referral
- Completed \((n = 58)\)

Consultation
- Completed \((n = 40)\)

Pre-surgery
- Completed \((n = 3)\)
New Consults

Assessed for eligibility
(n = 284)

Excluded (n = 92)
- Declined to participate (n = 30)
- Not knee OA (n = 13)
- Not new referral (n = 6)
- Non-English speaking (n = 5)
- Mentally unable to consent (n = 2)
- No show (n = 12)
- Missed (n = 24)

Enrolled (n = 192)

3-month follow-up
- Completed (n = 100)
- Missed assessment (n = 57)
- Did not reach follow-up (n = 1)
- Underwent TKA (n = 10)
- Withdrawn (n = 24)
  - Withdrew consent (n = 21)
  - Lost to follow-up (n = 2)
  - No longer had someone to translate (n = 2)
  - Underwent TKA elsewhere (n = 2)

6-month follow-up
- Completed (n = 87)
- Missed assessment (n = 21)
- Did not reach follow-up (n = 38)
- Underwent TKA (n = 6)
- Withdrawn (n = 5)
  - Withdrew consent (n = 1)
  - Lost to follow-up (n = 3)
  - Underwent TKA elsewhere (n = 1)

9-month follow-up
- Completed (n = 43)
- Missed assessment (n = 23)
- Did not reach follow-up (n = 13)
- Underwent TKA (n = 24)
- Withdrawn (n = 3)
  - Withdrew consent (n = 1)
  - Lost to follow-up (n = 1)
  - Underwent TKA elsewhere (n = 1)

12-month follow-up
- Completed (n = 17)
- Missed assessment (n = 27)
- Did not reach follow-up (n = 29)
- Underwent TKA (n = 6)
- Withdrawn (n = 0)
Figure 4: Participant flow through the study
Table 5: Demographic characteristics of study participants

<table>
<thead>
<tr>
<th>Characteristic*</th>
<th>New referrals ($n = 58$)</th>
<th>New consults ($n = 192$)</th>
<th>Pre-surgical ($n = 119$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>68.3 ± 9.3</td>
<td>66.0 ± 9.5</td>
<td>66.8 ± 8.9</td>
</tr>
<tr>
<td>Female</td>
<td>31 (53.4)</td>
<td>116 (60.4)</td>
<td>68 (56.7)</td>
</tr>
<tr>
<td>BMI</td>
<td>31.4 ± 7.9</td>
<td>32.0 ± 8.3</td>
<td>34.9 ± 7.9</td>
</tr>
<tr>
<td>Dominant side – right</td>
<td>51 (87.9)</td>
<td>171 (89.1)</td>
<td>114 (95.0)</td>
</tr>
<tr>
<td>Affected knee – right</td>
<td>25 (43.1)</td>
<td>103 (53.6)</td>
<td>60 (50.0)</td>
</tr>
<tr>
<td>Contralateral symptoms</td>
<td>41 (70.7)</td>
<td>157 (81.8)</td>
<td>80 (66.7)</td>
</tr>
<tr>
<td>Previous joint replacement</td>
<td>6 (10.3)</td>
<td>19 (9.9)</td>
<td>40 (33.3)</td>
</tr>
<tr>
<td>Global rating of knee pain (0–10)</td>
<td>6.6 ± 2.3</td>
<td>5.4 ± 2.4</td>
<td>5.3 ± 2.2</td>
</tr>
<tr>
<td>PASS 2 – yes</td>
<td>23 (39.7)</td>
<td>96 (50.0)</td>
<td>N/A</td>
</tr>
<tr>
<td>Living arrangements</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alone</td>
<td>12 (20.7)</td>
<td>52 (27.1)</td>
<td>25 (20.8)</td>
</tr>
<tr>
<td>With spouse/partner</td>
<td>42 (72.4)</td>
<td>108 (56.3)</td>
<td>78 (65.0)</td>
</tr>
<tr>
<td>With family</td>
<td>3 (5.2)</td>
<td>32 (16.8)</td>
<td>17 (14.2)</td>
</tr>
<tr>
<td>Residential care facility</td>
<td>1 (1.7)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Stairs at home – yes</td>
<td>49 (84.5)</td>
<td>137 (71.6)</td>
<td>70 (58.3)</td>
</tr>
<tr>
<td>Employment status†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retired</td>
<td>32 (55.2)</td>
<td>105 (55.3)</td>
<td>75 (63.0)</td>
</tr>
<tr>
<td>Full time</td>
<td>11 (19.0)</td>
<td>49 (25.8)</td>
<td>17 (14.2)</td>
</tr>
<tr>
<td>Part time</td>
<td>6 (10.3)</td>
<td>12 (6.3)</td>
<td>12 (10.0)</td>
</tr>
<tr>
<td>Self-employed</td>
<td>2 (3.4)</td>
<td>2 (1.1)</td>
<td>4 (3.4)</td>
</tr>
<tr>
<td>Volunteer</td>
<td>1 (1.7)</td>
<td>2 (1.1)</td>
<td>1 (0.8)</td>
</tr>
<tr>
<td>Long-term disability</td>
<td>0</td>
<td>8 (4.2)</td>
<td>4 (3.3)</td>
</tr>
<tr>
<td>Temporary sick leave</td>
<td>0</td>
<td>5 (2.6)</td>
<td>4 (3.3)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>0</td>
<td>3 (1.6)</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>4 (2.1)</td>
<td>2 (1.7)</td>
</tr>
<tr>
<td>Annual household income‡</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;$20,000</td>
<td>5 (8.6)</td>
<td>29 (15.3)</td>
<td>12 (10.0)</td>
</tr>
<tr>
<td>$20,000–$40,000</td>
<td>13 (22.4)</td>
<td>49 (25.8)</td>
<td>24 (20.8)</td>
</tr>
<tr>
<td>$40,000–$60,000</td>
<td>7 (12.1)</td>
<td>29 (15.3)</td>
<td>24 (20.0)</td>
</tr>
</tbody>
</table>
BMI, body mass index; TJA, total joint arthroplasty; TKA, total knee arthroplasty; PASS, patient acceptable symptom state.

*Values are reported as means ± SD for continuous parameters and n (%) for categorical parameters.

†Data available for 53 new referrals, 184 new consults and 114 pre-surgical patients.

‡Had access to a computer and an email address or could complete questionnaires online with the help of a relative or friend.

### 5.1 Primary Objective

#### 5.1.1 Healthcare Resource Use

We divided the results of the healthcare resource use questionnaire into two sections: conservative treatments (Table 6) and diagnostic imaging tests (Table 7). Results are presented by stage of care: (1) prior to referral, (2) from date of inclusion on the surgical wait list to TKA (pre-surgery), and (3) from initial consultation during which patients were not booked for TKA but were followed for approximately five years post-consultation (long term).

#### 5.1.1.1 Conservative Treatments

The frequency of conservative treatments tried at the three stages of care are listed in Table 8. The most commonly used treatments at each stage of care were pharmacotherapy, lifestyle/activity modification, and exercise. 73.8% of patients reported having used topical NSAIDs prior to their referral, while 64% of long-term follow-up patients had tried physiotherapy since their initial consultation. Prior to referral, 123 of 248 (49.6%) patients had tried physiotherapy, of which 21 discontinued treatment sooner than recommended. Unaffordability and pain were the two most commonly cited reasons for discontinuation. 11 patients chose not to pursue physiotherapy despite it being recommended for various reasons.
(e.g., skeptical about its benefits, could do exercises independently, insufficient symptoms, too far away from home).

142 (57.3%) participants had received injections prior to referral, most often corticosteroid. 12 (4.8%) received a recommendation for injections but opted out. Reasons included patient perceptions that injections are costly, ineffective in controlling symptoms in the long term, or not needed at the time. The referring GP administered injections in 37.5% of the cases. Analgesics and NSAIDs were the two most commonly tried drug classes prior to referral (68.1% and 57.7%) and pre-surgery (58.8% and 66.4%).

Table 6: Patient-reported use of conservative treatments at different stages of care*

<table>
<thead>
<tr>
<th>Conservative treatment</th>
<th>Prior to referral† (n = 248§)</th>
<th>Pre-surgery‡ (n = 119)</th>
<th>Long term‖ (n = 25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physiotherapy</td>
<td>123 (49.6)</td>
<td>40 (33.6)</td>
<td>16 (64.0)</td>
</tr>
<tr>
<td>No but recommended</td>
<td>11 (4.4)</td>
<td>1 (0.8)</td>
<td>0</td>
</tr>
<tr>
<td>Chiropractic therapy</td>
<td>17 (6.9)</td>
<td>6 (5.0)</td>
<td>2 (8.0)</td>
</tr>
<tr>
<td>No but recommended</td>
<td>1 (0.4)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Occupational therapy</td>
<td>7 (2.8)</td>
<td>4 (3.4)</td>
<td>1 (4.0)</td>
</tr>
<tr>
<td>No but recommended</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Massage therapy</td>
<td>33 (13.3)</td>
<td>9 (7.6)</td>
<td>4 (16.0)</td>
</tr>
<tr>
<td>Osteopathy</td>
<td>8 (3.2)</td>
<td>1 (0.8)</td>
<td>1 (4.0)</td>
</tr>
<tr>
<td>Acupuncture</td>
<td>18 (7.3)</td>
<td>7 (5.9)</td>
<td>1 (4.0)</td>
</tr>
<tr>
<td>Pedorthist/orthotist services</td>
<td>57 (23.0)</td>
<td>14 (11.8)</td>
<td>2 (8.0)</td>
</tr>
<tr>
<td>Injections</td>
<td>142 (57.3)</td>
<td>33 (27.7)</td>
<td>4 (16.0)</td>
</tr>
<tr>
<td>Corticosteroid</td>
<td>122 (49.2)</td>
<td>29 (24.4)</td>
<td>0</td>
</tr>
<tr>
<td>Hyaluronic acid</td>
<td>37 (14.9)</td>
<td>1 (0.8)</td>
<td>1 (4.0)</td>
</tr>
<tr>
<td>Unknown</td>
<td>10 (4.0)</td>
<td>2 (1.7)</td>
<td>1 (4.0)</td>
</tr>
<tr>
<td>Other</td>
<td>2 (0.8)</td>
<td>0</td>
<td>1 (4.0)</td>
</tr>
<tr>
<td>No but recommended</td>
<td>12 (4.8)</td>
<td>1 (0.8)</td>
<td>1 (4.0)</td>
</tr>
</tbody>
</table>
### Weight loss

<table>
<thead>
<tr>
<th></th>
<th>Pounds lost, mean ± SD</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>53 (21.4)</td>
<td>34 (28.6)</td>
<td>8 (32.0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20.0 ± 21.3</td>
<td>13.4 ± 13.1</td>
<td>31.2 ± 29.0</td>
<td></td>
</tr>
</tbody>
</table>

### Exercise

<table>
<thead>
<tr>
<th></th>
<th>Aerobic</th>
<th>Resistance</th>
<th>Stretching</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>176 (71.0)</td>
<td>128 (51.6)</td>
<td>88 (35.5)</td>
<td>116 (46.8)</td>
</tr>
<tr>
<td></td>
<td>92 (77.3)</td>
<td>75 (63.0)</td>
<td>39 (32.8)</td>
<td>67 (56.3)</td>
</tr>
<tr>
<td></td>
<td>17 (68.0)</td>
<td>12 (48.0)</td>
<td>7 (28.0)</td>
<td>9 (36.0)</td>
</tr>
<tr>
<td></td>
<td>4 (1.6)</td>
<td>0</td>
<td>2 (8.0)</td>
<td></td>
</tr>
</tbody>
</table>

### Activity modification

<table>
<thead>
<tr>
<th></th>
<th>201 (81.0)</th>
<th>93 (72.8)</th>
<th>11 (44.0)</th>
</tr>
</thead>
</table>

### Gait aid

<table>
<thead>
<tr>
<th></th>
<th>92 (37.1)</th>
<th>52 (43.7)</th>
<th>7 (28.0)</th>
</tr>
</thead>
</table>

### Topical NSAID

<table>
<thead>
<tr>
<th></th>
<th>183 (73.8)</th>
<th>70 (58.8)</th>
<th>8 (32.0)</th>
</tr>
</thead>
</table>

### Knee sleeve/brace

<table>
<thead>
<tr>
<th></th>
<th>105 (42.3)</th>
<th>42 (35.3)</th>
<th>6 (24.0)</th>
</tr>
</thead>
</table>

### Specialized footwear

<table>
<thead>
<tr>
<th></th>
<th>76 (30.6)</th>
<th>32 (26.9)</th>
<th>4 (16.0)</th>
</tr>
</thead>
</table>

### Medications

<table>
<thead>
<tr>
<th></th>
<th>209 (84.3)</th>
<th>107 (89.9)</th>
<th>19 (76.0)</th>
</tr>
</thead>
</table>

### NSAIDs

<table>
<thead>
<tr>
<th></th>
<th>143 (57.7)</th>
<th>79 (66.4)</th>
<th>7 (28.0)</th>
</tr>
</thead>
</table>

### Analgesics

<table>
<thead>
<tr>
<th></th>
<th>169 (68.1)</th>
<th>70 (58.8)</th>
<th>6 (24.0)</th>
</tr>
</thead>
</table>

### Steroids

<table>
<thead>
<tr>
<th></th>
<th>6 (2.4)</th>
<th>8 (6.7)</th>
<th>1 (4.0)</th>
</tr>
</thead>
</table>

### Anti-rheumatoid

<table>
<thead>
<tr>
<th></th>
<th>5 (2.0)</th>
<th>3 (2.5)</th>
<th>0</th>
</tr>
</thead>
</table>

### Other

<table>
<thead>
<tr>
<th></th>
<th>22 (8.9)</th>
<th>24 (20.2)</th>
<th>0</th>
</tr>
</thead>
</table>

---

*Values are reported as *n* (%) unless otherwise indicated.
†Data collected at the time of referral or initial consultation.
‡n = 190 new consults + 58 new referrals.
§At pre-admission appointment prior to undergoing TKA.
‖Approximately five years post-consultation.

At the time of assessment, 48% (12 of 25) of long-term follow-up patients had undergone surgery on their knee. Surgical procedures included unilateral TKA (n = 6), bilateral TKA (n = 1), UKA (n = 1), arthroscopy (n = 2), high tibial osteotomy with microfacture (n = 1), and meniscal repair with anterior cruciate ligament reconstruction (n = 1). Given that surgery has a significant impact on patients’ quality of life and health-related costs, these outcomes are reported separately for recipients of surgery at the long-term follow-up.
5.1.1.2 Diagnostic Imaging

Prior to their referral, 238 of 248 (96%) patients had undergone x-rays and 52 (21%) had undergone MRI examinations. In the long-term follow-up group, radiographs were obtained for 68% of patients since their initial surgical consultation, while MRI scans were ordered for 20%. Most patients were aware of the results of their imaging tests. At initial surgical consultation, the majority was able to report the results of their x-rays (64.7%) and MRI scans (57.7%).

Table 7: Patient-reported use and results of diagnostic imaging tests at different stages of care

<table>
<thead>
<tr>
<th>Imaging test and results*</th>
<th>Prior to referral (n = 248)</th>
<th>Pre-surgery§ (n = 119)</th>
<th>Long-term follow-up‖ (n = 25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-ray</td>
<td>238 (96.0)</td>
<td>38 (90.8)</td>
<td>17 (68.0)</td>
</tr>
<tr>
<td>Mild/moderate OA</td>
<td>12.2</td>
<td>5.3</td>
<td>2</td>
</tr>
<tr>
<td>Severe OA</td>
<td>52.7</td>
<td>65.8</td>
<td>7</td>
</tr>
<tr>
<td>Unknown</td>
<td>35.3</td>
<td>28.9</td>
<td>8</td>
</tr>
<tr>
<td>MRI</td>
<td>52 (21.0)</td>
<td>5 (4.2)</td>
<td>5 (20.0)</td>
</tr>
<tr>
<td>Mild/moderate OA</td>
<td>7.7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Severe OA</td>
<td>50.0</td>
<td>40.0</td>
<td>2</td>
</tr>
<tr>
<td>Unknown</td>
<td>42.3</td>
<td>60.0</td>
<td>3</td>
</tr>
<tr>
<td>MRI arthrogram</td>
<td>7 (2.8)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mild/moderate OA</td>
<td>28.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe OA</td>
<td>42.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>28.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT scan</td>
<td>11 (4.4)</td>
<td>3 (6.4)</td>
<td>0</td>
</tr>
<tr>
<td>Mild/moderate OA</td>
<td>9.1</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Severe OA</td>
<td>45.5</td>
<td>66.7</td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>45.5</td>
<td>33.3</td>
<td></td>
</tr>
<tr>
<td>Ultrasound</td>
<td>10 (4.0)</td>
<td>1 (2.1)</td>
<td>3 (12.0)</td>
</tr>
<tr>
<td>Mild/moderate OA</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Severe OA</td>
<td>50.0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Unknown</td>
<td>50.0</td>
<td>100</td>
<td>2</td>
</tr>
</tbody>
</table>

*Values are reported as n (%) for imaging tests and as % for test results.
†Data collected at the time of referral or initial consultation.
‡n = 190 new consults + 58 new referrals.
§Assessed at pre-admission appointment prior to undergoing TKA.
‖Approximately five years post-consultation.
5.1.2 Costs

We calculated OA-related costs over the continuum of care from the healthcare payer, patient/private insurer, and societal perspectives (Table 8). At each follow-up, a considerable proportion of the total (societal) cost was incurred by the patient/private insurer (Figure 5). Figures 6-8 illustrate the distribution of costs at initial surgical consultation, pre-surgery, and long-term follow-up. At initial consultation, 27% of the total cost was attributed to informal caregiver assistance with daily activities. Overall, productivity costs accounted for the greatest proportion of total costs (79% at initial consultation, 82% at pre-surgery, 58% at long-term follow-up for patients who had received surgical treatment, and 83% at long-term follow-up for patients who had not undergone surgery). The greatest costs incurred by both the healthcare payer and patient/private insurer were at 6 weeks post-surgery, reflecting the costs of acute care (TKA and hospital stay) and post-operative rehabilitation. In the long-term follow-up group, patients who had received surgical treatment reported significantly lower costs compared to those who did not undergo surgery.

Table 8: Costs over the continuum of care by payer perspective

<table>
<thead>
<tr>
<th>Stage of care</th>
<th>Healthcare payer (MOHLTC)</th>
<th>% of total cost</th>
<th>Patient/private insurer</th>
<th>% of total cost</th>
<th>Societal (total cost)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial consultation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(n = 231)</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>116.48 ± 184.04</td>
<td>6.8%</td>
<td>1,598.39 ± 3,675.87</td>
<td>93.2%</td>
<td>1,714.87 ± 2,910.44</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>76.48 (118.78)</td>
<td></td>
<td>242.57 (1,113.86)</td>
<td></td>
<td>414.30 (1,128.96)</td>
</tr>
<tr>
<td>Range</td>
<td>1,826.78</td>
<td></td>
<td>33,952.85</td>
<td></td>
<td>34,050.45</td>
</tr>
<tr>
<td><strong>3 months post-consultation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(n = 127)</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>105.00 ± 198.91</td>
<td>3.8%</td>
<td>2,635.97 ± 6,677.55</td>
<td>96.2%</td>
<td>2,740.98 ± 6,684.52</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>42.60 (154.40)</td>
<td></td>
<td>279.51 (1,535.87)</td>
<td></td>
<td>417.80 (1,615.65)</td>
</tr>
<tr>
<td>Range</td>
<td>1,749.42</td>
<td></td>
<td>52,495.00</td>
<td></td>
<td>52,562.40</td>
</tr>
<tr>
<td><strong>6 months post-consultation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(n = 93)</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>103.86 ± 203.66</td>
<td>4.2%</td>
<td>2,318.86 ± 4,642.18</td>
<td>95.8%</td>
<td>2,422.73 ± 4,677.75</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>36.03 (154.40)</td>
<td></td>
<td>431.00 (1,891.03)</td>
<td></td>
<td>505.45 (2,130.84)</td>
</tr>
<tr>
<td>Range</td>
<td>1,749.42</td>
<td></td>
<td>25,047.02</td>
<td></td>
<td>25,278.62</td>
</tr>
<tr>
<td>Time Period</td>
<td>n</td>
<td>Mean ± SD</td>
<td>Median (IQR)</td>
<td>Range</td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----</td>
<td>----------------</td>
<td>----------------</td>
<td>----------------</td>
<td></td>
</tr>
<tr>
<td><strong>9 months post-consultation (n = 52)</strong></td>
<td></td>
<td>65.41 ± 98.56</td>
<td>33.30 (83.39)</td>
<td>2,589.05 ± 5,513.81</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td></td>
<td>2.6%</td>
<td>27,109.00</td>
<td>97.4%</td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td></td>
<td></td>
<td>485.82 (2,024.21)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td></td>
<td>2,615.69 ± 5,484.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1 year post-consultation (n = 20)</strong></td>
<td></td>
<td>64.58 (142.14)</td>
<td>543.63</td>
<td>543.63</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td></td>
<td>33.30 (83.39)</td>
<td>44,551.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td></td>
<td>499.39 (3,765.48)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td>562.53 (5,153.33)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pre-surgery (n = 141^†)</strong></td>
<td></td>
<td>299.58 ± 82.35</td>
<td>262.45 (80.83)</td>
<td>2,085.37 ± 5,035.34</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td></td>
<td>12.6%</td>
<td>1,146.92 ± 3,254.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td></td>
<td>122.54 (838.32)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td>1,355.35 ± 5,055.13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>6 weeks post-surgery (n = 85)</strong></td>
<td></td>
<td>7,346.24 ± 288.71</td>
<td>7,269.91 (81.60)</td>
<td>7,310.24 ± 8,879.38</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td></td>
<td>50.1%</td>
<td>65,772.14</td>
<td>49.9%</td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td></td>
<td>4,936.84 (8,812.00)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td>14,656.48 ± 8,838.40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>6 months post-surgery (n = 57)</strong></td>
<td></td>
<td>208.42 ± 957.91</td>
<td>64.80 (129.98)</td>
<td>1,146.92 ± 3,254.51</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td></td>
<td>15.5%</td>
<td>19,093.26</td>
<td>84.5%</td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td></td>
<td>59.31 (506.79)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td>1,355.35 ± 3,598.62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>9 months post-surgery (n = 41)</strong></td>
<td></td>
<td>244.74 ± 1,154.54</td>
<td>24.05 (94.16)</td>
<td>1,603.61 ± 4,691.87</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td></td>
<td>15.4%</td>
<td>23,266.93</td>
<td>84.6%</td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td></td>
<td>195.31 (614.00)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td>1,848.35 ± 4,819.13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1 year post-surgery (n = 18)</strong></td>
<td></td>
<td>138.52 ± 328.40</td>
<td>45.87 (123.41)</td>
<td>2,579.53 ± 4,446.37</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td></td>
<td>5.1%</td>
<td>13,763.00</td>
<td>94.9%</td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td></td>
<td>143.31 (2,573.62)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td>2,718.05 ± 4,646.69</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>15 months post-surgery (n = 5)</strong></td>
<td></td>
<td>53.88 ± 73.44</td>
<td>9.05 (97.60)</td>
<td>35.51 ± 76.34</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td></td>
<td>60.3%</td>
<td>0.00 (5.54)</td>
<td>39.7%</td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td>162.73</td>
<td>172.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Long term, surgery§
(n = 12)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
<th>Value 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>64.91 ± 97.92</td>
<td>437.04 ± 1,224.50</td>
<td>501.95 ± 1,244.17</td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>0 (93.06)</td>
<td>7.05 (136.38)</td>
<td>43.30 (275.54)</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>293.85</td>
<td>4,110.00</td>
<td>4,210.28</td>
<td></td>
</tr>
</tbody>
</table>

Long term, no surgery§
(n = 14)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
<th>Value 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>816.58 ± 2,699.44</td>
<td>1,228.30 ± 2,371.09</td>
<td>2,044.88 ± 3,414.59</td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>78.00 (176.76)</td>
<td>176.47 (1,657.89)</td>
<td>370.59 (1,938.54)</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>10,189.68</td>
<td>8,960.00</td>
<td>10,637.68</td>
<td></td>
</tr>
</tbody>
</table>

TKA, total knee arthroplasty.
*Costs are reported in 2018 CAD ($).
†n = 191 new consults + 40 new referrals.
‡n = 119 pre-surgical patients + 19 new consults + 3 new referrals who had undergone surgery at the end of the follow-up period.
§Costs reported separately for long-term follow-up patients who had undergone surgery on their knee since their initial consultation and for those who did not.
Figure 5: Knee OA-related costs over the continuum of care
(unadjusted means, 95% CIs)
Figure 6: Distribution of direct and indirect costs of OA at initial surgical consultation

Figure 7: Distribution of direct and indirect costs of OA prior to surgery
Figure 8: Distribution of direct and indirect costs of OA at long-term follow-up for patients who had undergone surgical treatment vs. those who had not
5.1.3 Quality of Life

EQ-5D (index and VAS), SF-12 (PCS and MCS), and WOMAC (pain, stiffness, function and total) scores at referral, initial consultation, pre-surgery, and long-term follow-up are reported in Table 9. Figures 9, 10, and 11 present the trajectory of HRQoL scores over the continuum of care. Mean scores at referral, initial consultation, and pre-surgery were similar for all HRQoL measures. Overall, patients reported an improvement in HRQoL post-operatively. Similarly, patients in the long-term follow-up group who had received surgical treatment reported better outcomes (higher EQ-5D and SF-12 scores and lower WOMAC scores) compared to those who had not. The high variability in HRQoL scores at 12 months post-consultation and 15 months post-surgery may be explained by the small sample size at both follow-ups (n = 25 and n = 5, respectively).

Table 9: QoL questionnaire scores at four stages along the continuum of care

<table>
<thead>
<tr>
<th>Score*</th>
<th>Referral (n = 58)</th>
<th>Consultation (n = 231†)</th>
<th>Presurgery (n = 151‡)</th>
<th>Long term, had surgery§ (n = 12)</th>
<th>Long term, no surgery§ (n = 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQ-5D index (0–1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>0.78 ± 0.15</td>
<td>0.78 ± 0.11</td>
<td>0.79 ± 0.10</td>
<td>0.88 ± 0.06</td>
<td>0.85 ± 0.08</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>0.82 (0.07)</td>
<td>0.81 (0.06)</td>
<td>0.82 (0.08)</td>
<td>0.86 (0.00)</td>
<td>0.85 (0.03)</td>
</tr>
<tr>
<td>Range</td>
<td>0.75</td>
<td>0.76</td>
<td>0.68</td>
<td>0.19</td>
<td>0.29</td>
</tr>
<tr>
<td>EQ-5D VAS (0–100)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>65.9 ± 19.1</td>
<td>61.8 ± 18.9</td>
<td>64.2 ± 18.7</td>
<td>74.33 ± 22.10</td>
<td>79.2 ± 11.0</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>70.0 (23.0)</td>
<td>62.0 (25.0)</td>
<td>70.0 (29.75)</td>
<td>80.5 (19.3)</td>
<td>84.0 (16.0)</td>
</tr>
<tr>
<td>Range</td>
<td>95.0</td>
<td>90.0</td>
<td>90.0</td>
<td>74.0</td>
<td>39.0</td>
</tr>
<tr>
<td>SF-12 PCS (0–100)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>30.5 ± 8.2</td>
<td>30.5 ± 8.0</td>
<td>31.2 ± 8.1</td>
<td>44.5 ± 10.4</td>
<td>41.7 ± 8.9</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>29.7 (10.2)</td>
<td>30.1 (11.5)</td>
<td>31.8 (11.2)</td>
<td>46.4 (12.3)</td>
<td>41.6 (10.3)</td>
</tr>
<tr>
<td>Range</td>
<td>44.8</td>
<td>45.8</td>
<td>42.9</td>
<td>37.3</td>
<td>35.9</td>
</tr>
<tr>
<td>SF-12 MCS (0–100)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>52.8 ± 10.9</td>
<td>49.9 ± 12.2</td>
<td>52.4 ± 10.3</td>
<td>58.1 ± 6.9</td>
<td>51.6 ± 8.5</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>53.9 (16.5)</td>
<td>51.2 (19.2)</td>
<td>52.9 (16.6)</td>
<td>59.8 (8.4)</td>
<td>52.0 (11.6)</td>
</tr>
<tr>
<td>Range</td>
<td>52.0</td>
<td>60.3</td>
<td>46.6</td>
<td>22.9</td>
<td>30.0</td>
</tr>
<tr>
<td>WOMAC pain (0–20)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>10.8 ± 3.6</td>
<td>10.3 ± 3.6</td>
<td>9.5 ± 3.8</td>
<td>3.8 ± 5.2</td>
<td>5.2 ± 4.8</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>11.0 (6.0)</td>
<td>10.0 (5.0)</td>
<td>10.0 (5.0)</td>
<td>2.0 (5.3)</td>
<td>4.0 (7.0)</td>
</tr>
<tr>
<td>Range</td>
<td>16.0</td>
<td>19.0</td>
<td>18.0</td>
<td>18.0</td>
<td>14.0</td>
</tr>
</tbody>
</table>
### WOMAC Stiffness (0–8)

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
<th></th>
<th>Median (IQR)</th>
<th></th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>WOMAC stiffness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>4.1 ± 1.9</td>
<td></td>
<td>4.0 (2.5)</td>
<td></td>
<td>8.0</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>4.5 ± 1.7</td>
<td></td>
<td>4.0 (2.0)</td>
<td></td>
<td>8.0</td>
</tr>
<tr>
<td>Range</td>
<td>4.2 ± 1.7</td>
<td></td>
<td>4.0 (3.0)</td>
<td></td>
<td>8.0</td>
</tr>
<tr>
<td>WOMAC function</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>2.0 ± 1.9</td>
<td></td>
<td>2.0 (2.5)</td>
<td></td>
<td>5.0</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>2.8 ± 2.4</td>
<td></td>
<td>2.0 (3.0)</td>
<td></td>
<td>8.0</td>
</tr>
</tbody>
</table>

### WOMAC Function (0–68)

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
<th></th>
<th>Median (IQR)</th>
<th></th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>WOMAC function</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>34.9 ± 12.5</td>
<td></td>
<td>34.0 (20.0)</td>
<td></td>
<td>52.0</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>34.9 ± 12.6</td>
<td></td>
<td>35.0 (17.0)</td>
<td></td>
<td>67.0</td>
</tr>
<tr>
<td>Range</td>
<td>35.6 ± 11.8</td>
<td></td>
<td>37.0 (15.0)</td>
<td></td>
<td>67.1</td>
</tr>
<tr>
<td>WOMAC function</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>12.0 ± 14.4</td>
<td></td>
<td>8.0 (17.0)</td>
<td></td>
<td>47.0</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>17.3 ± 15.4</td>
<td></td>
<td>14.0 (20.0)</td>
<td></td>
<td>45.0</td>
</tr>
</tbody>
</table>

### Total WOMAC (0–96)

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
<th></th>
<th>Median (IQR)</th>
<th></th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total WOMAC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>49.8 ± 16.5</td>
<td></td>
<td>48.0 (25.5)</td>
<td></td>
<td>67.0</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>49.7 ± 16.8</td>
<td></td>
<td>50.0 (23.0)</td>
<td></td>
<td>92.0</td>
</tr>
<tr>
<td>Range</td>
<td>49.1 ± 15.4</td>
<td></td>
<td>51.0 (21.0)</td>
<td></td>
<td>86.6</td>
</tr>
<tr>
<td>WOMAC function</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>17.8 ± 20.6</td>
<td></td>
<td>11.5 (23.8)</td>
<td></td>
<td>70.0</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>25.2 ± 22.2</td>
<td></td>
<td>18.0 (31.0)</td>
<td></td>
<td>65.0</td>
</tr>
</tbody>
</table>

**EQ-5D-5L**, EuroQoL five dimensions five-level; **VAS**, visual analogue scale; **SF-12**, short form health survey (12-item); **MCS**, mental component score; **PCS**, physical component score; **WOMAC**, Western Ontario and McMaster Universities osteoarthritis index.

*Lower scores on the WOMAC and higher scores on the SF-12 and EQ-5D indicate better outcomes.

†\( n = 188 \) new consults + 43 new referrals.

‡\( n = 119 \) pre-surgical patients + 32 new consults who had undergone surgery at the time of analysis.

§Costs are reported separately for patients in the long-term follow-up group who had undergone surgery on their knee since their initial consultation.

**Figure 9**: Change in EQ-5D index and VAS scores over the continuum of care (unadjusted means, 95% CIs)
Figure 10: Change in SF-12 PCS and PCS over the continuum of care
(unadjusted means, 95% CIs)

Figure 11: Change in WOMAC scores over the continuum of care
(unadjusted means, 95% CIs)
5.2 Secondary Objective

5.2.1 Proportion of Inappropriate Referrals

138 of 232 (59.5%) patients were scheduled for surgery following their initial consultation (Table 10). Of the 137 patients deemed timely referrals, 10 were unwilling to undergo TKA. The majority of referral requests (93.5%) were sent by a primary care provider.

In most cases (16 of 19), priority rating 1 was assigned because OA was advanced and symptomatic for a long period of time. Priority rating 3 or no rating were most often assigned to patients who had not yet exhausted conservative treatment options (54.5% and 35.2%, respectively), followed by those with insufficient OA severity (40.1% and 35.2%, respectively).

Table 10: Surgical appropriateness of new consults and new referrals* (n = 232)

<table>
<thead>
<tr>
<th>Priority rating</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (late referral)</td>
<td>19 (8.2)</td>
</tr>
<tr>
<td>2 (timely referral)</td>
<td>137 (59.1)</td>
</tr>
<tr>
<td>3 (early referral)</td>
<td>22 (9.5)</td>
</tr>
<tr>
<td>None†</td>
<td>54 (23.3)</td>
</tr>
</tbody>
</table>

TKA, total knee arthroplasty.

* n = 192 new consults + 40 new referrals who reached consult.
† Surgeon indicated that “patient should not have been referred to TKA at this time”.

Prior to surgical consultation, new referrals and new consults reported their willingness to undergo surgery using a five-point Likert-type scale (Table 11). Patients who were “unsure”, “probably unwilling” or “definitely unwilling” were asked to provide a reason. Overall, 46 patients (10.4% of new referrals and 20.3% of new consults) were unsure about or unwilling to undergo TKA. Among these, 13 believed that there were other treatment options available, 10 cited a need for more information (about OA, the risks and benefits of surgery, and
alternative treatments), nine reported insufficient symptoms for surgery, and nine were willing to consider TKA as an option in the future (e.g., closer to retirement).

Table 11: Willingness to undergo surgery at referral and initial consultation

<table>
<thead>
<tr>
<th>Willingness to undergo TKA</th>
<th>At referral (n = 58)</th>
<th>At consultation (n = 192)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definitely willing</td>
<td>43 (74.1)</td>
<td>133 (69.3)</td>
</tr>
<tr>
<td>Probably willing</td>
<td>9 (15.5)</td>
<td>20 (10.5)</td>
</tr>
<tr>
<td>Unsure</td>
<td>3 (5.2)</td>
<td>21 (10.9)</td>
</tr>
<tr>
<td>Probably unwilling</td>
<td>3 (5.2)</td>
<td>15 (7.8)</td>
</tr>
<tr>
<td>Definitely unwilling</td>
<td>0</td>
<td>3 (1.6)</td>
</tr>
</tbody>
</table>

5.2.2 Wait Times

Overall, the mean wait time between referral and surgical consultation (WT1) was 3.6 months (range 0.1–18.4) and the mean wait time between date of inclusion on the surgical wait list and TKA (WT2) was 9.6 months (range 1.4–22.2) (Table 12). At the end of the follow-up period, three new referrals had undergone surgery. These patients had a significantly shorter mean WT2 (3.6 months, range 2.5–4.3) compared to new consults (9.3 months, range 2.1–15.8) and pre-surgical patients (9.8 months, range 1.4–22.2).

Among patients recruited at their pre-admission appointment, those who were booked for TKA at a follow-up visit (n = 62) waited a median of 1.7 years (range, 0.5 months–10.3 years) between initial consultation and booking for surgery.
Table 12: Wait times (in months) from referral to initial consultation (WT1) and from date of inclusion on surgical wait list to TKA (WT2)

<table>
<thead>
<tr>
<th></th>
<th>New referrals</th>
<th>New consults</th>
<th>Pre-surgical</th>
<th>All patients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wait time (months)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>58</td>
<td>192</td>
<td>112*</td>
</tr>
<tr>
<td><strong>WT1</strong></td>
<td>Mean ± SD</td>
<td>3.8 ± 1.1</td>
<td>3.1 ± 1.5</td>
<td>4.2 ± 2.9</td>
</tr>
<tr>
<td></td>
<td>Median (IQR)</td>
<td>3.7 (1.2)</td>
<td>3.1 (1.8)</td>
<td>3.4 (2.5)</td>
</tr>
<tr>
<td></td>
<td>Range (min, max)</td>
<td>6.5 (1.8, 8.3)</td>
<td>12.7 (0.1, 12.8)</td>
<td>17.9 (0.5, 18.4)</td>
</tr>
<tr>
<td><strong>WT2</strong></td>
<td>n</td>
<td>3†</td>
<td>43‡</td>
<td>117§</td>
</tr>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>3.6 ± 1.0</td>
<td>9.3 ± 3.8</td>
<td>9.8 ± 3.8</td>
</tr>
<tr>
<td></td>
<td>Median (IQR)</td>
<td>3.9 (0.9)</td>
<td>10.3 (5.2)</td>
<td>9.9 (5.1)</td>
</tr>
<tr>
<td></td>
<td>Range (min, max)</td>
<td>1.8 (2.5, 4.3)</td>
<td>13.7 (2.1, 15.8)</td>
<td>20.8 (1.4, 22.2)</td>
</tr>
</tbody>
</table>

*Date of referral was not available in the hospital’s electronic medical record for seven pre-surgical patients.
†Three new referrals had undergone TKA at the time of analysis (WT2 = 2.5, 3.9 and 4.3 months).
‡43 new consults had undergone TKA at the time of analysis.
§One patient cancelled TKA twice and had not undergone surgery at the end of the follow-up period (i.e., within 9.9 months of initial pre-admission appointment).
Chapter 6

6 Discussion

The purpose of this study was to evaluate healthcare resource use, costs and HRQoL in patients with knee OA at different stages along the continuum of usual care. In addition, we determined the rate and determinants of inappropriate referrals and estimated wait times from referral to initial surgical consultation (WT1) and from consultation to TKA (WT2) at our center. Our findings are consistent with previous studies that demonstrated that the current primary care management of patients with knee OA is suboptimal. We found that conservative treatments were underused prior to referral, while the ordering of diagnostic imaging tests was not aligned with current CPGs. The perspective of the analysis had a significant impact on the results. At each stage of care, a substantial proportion of total costs were incurred by the patient/private insurer. While HRQoL remained relatively stable throughout WT1 and WT2, participants reported an improvement in health status post-operatively. Our results emphasize the need for improved education and guidance for patients and referring GPs to promote shared decision-making and appropriate and timely referral to TKA.

Prior to being referred, a considerable number of patients had not tried many of the core conservative treatments, including exercise (29%), injections (43%), physiotherapy (50%), NSAIDs (42%), and analgesics (32%). CPGs for the management of knee OA consistently recommend that all patients be offered a combination of pharmacological (NSAIDs, acetaminophen, tramadol and IA corticosteroid injections) and nonpharmacological interventions (education on self-management, exercise, weight loss, activity modification and physiotherapy) before TKA is considered. Only those patients who continue to experience significant pain and functional impairment despite conservative management should be referred to an orthopedic surgeon for consideration of TKA.

Our results are in line with the findings from previous studies, which found that a large subset of referrals are inappropriate and consists of patients who have not exhausted nonsurgical treatment options. To capture the use of injections and services from
alternative healthcare providers (physiotherapists, chiropractors, and occupational therapists), we asked patients to distinguish between never having tried the treatment and never having received a recommendation. For example, only 4% of patients indicated that they opted out of receiving an IA joint injection despite it being recommended. This suggests that the 43% of patients who reported never having tried injections had never received a recommendation from their primary care provider.

Although MRI is typically not indicated for the diagnosis of OA, 21% of participants reported undergoing MRI examinations prior to their referral. Similarly, a US study of new patients presenting with knee pain to an academic orthopedic sports medicine clinic (n = 599) found that 22% of patients underwent MRI prior to referral. Furthermore, while older CPGs recommend plain radiographs for the diagnosis of OA, the latest NICE guideline recommends that it be made clinically without imaging tests if patients meet the following three criteria: (1) are ≥45 years of age, (2) suffer from activity-related joint pain, and (3) experience either no morning joint-related stiffness or morning stiffness that lasts <30 minutes. Nevertheless, pre-referral x-rays were obtained for 96% of participants. These discrepancies between guideline recommendations and clinical practice indicate the need for clear indications to streamline screening and avoid the ordering of costly and unnecessary imaging tests.

A finding that is particularly relevant to the NRP is that most participants were aware of the results of their diagnostic imaging tests. For example, 65% of newly referred patients knew the results of their x-rays and 58% knew the results of their MRI. A feature of the NRP that enables patients to self-report their test results would avoid an additional point-of-contact, thereby improving the efficiency of the referral process.

To accurately assess the value of new clinical pathways for patients with knee OA, it is important to capture costs and HRQoL across the entire continuum of care, from referral to surgery and recovery. Healthcare costs are incurred by public payers (the MOHLTC), private insurers, as well as individual patients and their caregivers. In the present study, we estimated the costs and consequences of knee OA over time from the perspective of the MOHLTC, patient/private insurer and society, and determined the proportion of costs borne by each payer. Our results confirm the findings of other studies that have reported that the impact of
OA falls beyond the boundaries of the healthcare system. Costs incurred by the patient/private insurer accounted for the majority of the total (societal) mean cost at each follow-up (>85% of the total cost during WT2).

Across the components of care, the greatest proportion of costs were attributed to indirect or productivity costs. At initial surgical consultation, 38% of the mean total cost was attributed to lost leisure time, 27% to informal caregiver assistance, and 14% to time off from paid work. From the patient/private insurer perspective, costs increased during WT2, indicating that the economic burden of OA can be reduced by addressing the issue of excessive wait times for surgery. Hunter et al.\textsuperscript{20} argued that the overwhelming majority of OA-related costs are indirect and that studies often adopt the healthcare payer perspective alone, thereby underestimating the true burden of OA. A study commissioned by the Canadian Medical Association compared four priority procedures and found that wait times for TJA amounted to the highest societal costs.\textsuperscript{17} With an estimated 32% of patients unable to participate in their usual activities, a large proportion of these costs were attributed to productivity losses.

Marshall et al.\textsuperscript{145} conducted a similar economic evaluation in Alberta to measure the costs of TJA from one year pre-surgery to one year post-surgery. The authors found that the perspective of the analysis (healthcare payer vs. patient) had a significant impact on the results. 30% of the total cost was incurred by patients and attributed to time off work, travel expenditures, medications, and alternative healthcare provider visits. The significant variability in costs observed at each follow-up indicates that the majority of healthcare costs are borne by a small subset of the patient population. As the economic burden of OA continues to grow, it is important for WTMS to identify and target individuals who are at a higher risk of incurring greater costs.

To our knowledge, this is the first study to capture the change in HRQoL between referral and initial surgical consultation. Previous studies have looked at changes in HRQoL during WT2\textsuperscript{10}, as well as investigated the impact of the pre-surgery waiting time on post-operative health status.\textsuperscript{11,12} However, they did not take WT1 into account because of the methodological challenges in recruiting patients at the time of referral.\textsuperscript{11} Contrary to the prospective cohort study by Ackerman et al.\textsuperscript{10}, which found that more than half of patients waiting for TKA experienced a deterioration in HRQoL, our results suggest that patient health status remains
relatively stable throughout WT1 and WT2. Other studies evaluated the effect of waiting for TKA on post-operative outcomes and found that longer pre-surgery wait times (>6 and >9 months) were associated with poorer SF-36 and WOMAC scores at six months post-surgery, and poorer SF-12 and Knee Society function scores at one year post-surgery. This, coupled with the post-operative improvement in HRQoL observed in our study, suggests that shorter wait times would enable patients to achieve improved health status and wellbeing sooner.

The mean wait times were 3.6 months from referral to surgical consultation and 9.6 months from consultation to TKA, exceeding the national benchmarks (3 months and 6 months). We found that 41% of newly referred patients were not scheduled for TKA following their initial surgical consultation. This is similar to the proportion of inappropriate referrals previously reported at our center (>40%) and in another study conducted in Ontario (47%). Furthermore, nearly 20% of patients indicated that they were unwilling to undergo TKA, often citing inadequate conservative treatment, insufficient symptoms, and a lack of information as the primary reasons. Using the same five-point Likert-type scale, a population-based cohort study found that 66% (250 of 379) of individuals with disabling hip and knee OA were unwilling to consider TJA as a treatment option. Unwillingness was strongly associated with misperceptions about the indications for surgery and post-operative outcomes. These findings underscore the importance of patient and GP education and other strategies emphasizing appropriate and timely referral for improving the quality of both primary and specialty care.

This study captured a wide range of costs over a relevant time horizon and from multiple perspectives, revealing the significant patient burden incurred through out-of-pocket costs and productivity losses throughout the continuum of care. We also administered a unique and comprehensive questionnaire, developed and refined in previous studies conducted at our center, to capture the use of conservative treatments (allied health services, injections, and self-management strategies) and diagnostic imaging tests at different stages of care. In addition, we integrated additional follow-up questions to elucidate the barriers to treatment use and inform future efforts to optimize the conservative management of knee OA. Given the growing socioeconomic burden of OA, new strategies are needed to allocate healthcare resources more efficiently and tackle excessive wait times for TKA.
6.1 Limitations

This study has several limitations. First, the high attrition rate and small sample sizes at follow-up assessments decreased the precision of the cost and HRQoL estimates, as indicated by the large CIs (especially at 12 months post-consult and 15 months post-surgery) and quite possibly the validity of the estimates, although attrition was largely attributed to appointment postponements/cancellations or participants not reaching their next assessment by the end of the follow-up period. This suggests a random, rather than a systematic, component to missingness, thereby reducing the risk of bias.

Second, the post-operative follow-up period was limited to only 15 months. The latest edition of the national guidelines for economic evaluation recommends that the time horizon be long enough to capture all relevant costs and outcomes.\textsuperscript{146} Although the most important changes in health status have been reported to occur during the 12-month post-operative period\textsuperscript{147}, the selected time horizon was not sufficiently long to account for revision TKA. Given that revision TKA has a significant impact on costs and patient-reported outcomes, it would be appropriate to measure outcomes beyond the short–medium term.

Third, the healthcare resource use and cost estimates used in this single-center cohort study are specific to the local context. For instance, inpatient care at teaching hospitals is generally costlier due to the additional resources required for training and research.\textsuperscript{148} Consequently, the generalizability of our findings to other settings is unclear. However, the conclusions about the importance of capturing costs from multiple perspectives along the continuum of care are relevant outside this context. It is worth noting that we valued leisure time and unpaid caregiver assistance at the current minimum wage in Ontario ($14.00/hour, effective January 1, 2018). However, there is considerable variability in the costing approaches used to estimate indirect costs incurred by patients and caregivers, making comparisons challenging.
Chapter 7

7 Conclusion

We found that the use of conservative treatments and diagnostic imaging tests was not aligned with evidence-based guidelines, suggesting that the current primary care management of knee OA is suboptimal. At each stage along the continuum of care, a considerable proportion of total costs were borne by the patient or private insurer, rather than the public healthcare payer (MOHLTC). While patient-reported health status remained relatively stable from the time of referral until surgery, we observed an improvement in HRQoL post-operatively. Our results emphasize the need for increased guidance and decision support at the primary care level to address the current evidence-to-practice gap and promote appropriate and timely referral to TKA.

7.1 Future Directions

The escalating societal costs of knee OA underscore the need for innovative and sustainable strategies to reduce wait times without compromising the quality of patient care. This study evaluated healthcare resource use, costs and HRQoL over the continuum of usual care, prior to the implementation of the NRP. A subsequent study will determine the cost-effectiveness of the proposed NRP and its impact on wait times for initial surgical consultation and, ultimately, TKA.

Given the small sample size, the results of this study are preliminary and require further validation. However, they offer valuable insight into the shortcomings of current clinical practice and emphasize the importance of developing primary care interventions that target both patients and referring GPs. Thus, the present findings provide guidance on the design and implementation of the NRP and the optimization of resource allocation for patients with knee OA. The inclusion of additional orthopedic centers with varying patient volumes would improve the generalizability of our findings. Given the variety of WTMS that have been proposed and implemented across Canada, the evaluation of alternative clinical pathways is a much-needed focus for future research efforts to determine the most cost-effective model of care.
References


Malian SJ. Predictors of appropriate referral to total knee arthroplasty: a validation study. 2015;(Paper 2951).


Kingsbury SR, Conaghan PG. Current osteoarthritis treatment, prescribing influences and barriers to implementation in primary care. 2012:373-381. doi:10.1017/S1463423612000072

Cottrell E, Roddy E, Rathod T, Porcheret M, Foster NE. What influences general

60. Cottrell E, Foster NE, Porcheret M, Rathod T, Roddy E. GPs attitudes, beliefs and behaviours regarding exercise for chronic knee pain: a questionnaire survey. 2017. doi:10.1136/bmjopen-2016-014999


73. Lehnert BE, Bree RL. Analysis of appropriateness of outpatient ct and mri referred
from primary care clinics at an academic medical center: how critical is the need for improved decision support? *JACR*. 2010;7(3):192-197. doi:10.1016/j.jacr.2009.11.010


Adams RJ. Improving health outcomes with better patient understanding and education. 2010:61-72. doi:10.2147/RMHP.S7500


Boland L, Stacey D, Stacey D. Effect of patient decision aid was influenced by presurgical evaluation among patients with osteoarthritis of the knee. 2018;61:28-33.


120. Lopatina E, Damani Z, Bohm E, et al. Single-entry models (SEMs) for scheduled services: Towards a roadmap for the implementation of recommended practices. 2017;121:963-970.


125. Curry L, Reed MH. Electronic decision support for diagnostic imaging in a primary care setting. 2011:267-270. doi:10.1136/amiajnl-2011-000049


131. Roos EM, Klässbo M, Lohmander LS. WOMAC osteoarthritis index. *Scand J*


Appendices

Appendix A: Ethics Approval Form

Western University Health Science Research Ethics Board
HSREB Delegated Initial Approval Notice

Principal Investigator: Dr. Robert Giffen
Department & Institution: Schulich School of Medicine and Dentistry/Surgery, Western University

Review Type: Delegated
HSREB File Number: 07940
Study Title: A study to investigate the cost-effectiveness of a new referral pathway for total knee replacement.
HSREB Initial Approval Date: August 15, 2016
HSREB Expiry Date: August 15, 2017

Documents Approved and/or Received for Information:

<table>
<thead>
<tr>
<th>Document Name</th>
<th>Comments</th>
<th>Version Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western University Protocol</td>
<td>Received August 9, 2016</td>
<td></td>
</tr>
<tr>
<td>Recruitment Form</td>
<td>Recruitment Accept</td>
<td>2016/08/09</td>
</tr>
<tr>
<td>Letter of Information &amp; Consent</td>
<td>Usual Care</td>
<td>2016/08/09</td>
</tr>
<tr>
<td>Letter of Information &amp; Consent</td>
<td>NRP Group</td>
<td>2016/08/09</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Appendix A - Non-surgical additional follow-up</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Appendix B - New referral pathway: Follow up with patients re-directed from specialist appointment</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Appendix C - Demographics</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Appendix D - Charlson Comorbidity Index</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Appendix E - WOMAC</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Appendix F - SF-12</td>
<td>2016/05/01</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Appendix G - EQ-5D</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Appendix H - EQ-5D Index</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Appendix I - Surgical Consultation Form</td>
<td>2016/06/20</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Appendix J - NRP screened out patients interview guide</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Appendix J - Patient Questions for NRP - Received June 21, 2016</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Cost form A</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Cost form B</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Cost form C</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Cost form D</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Cost form E</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Cost form F</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Cost form G</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Cost form H</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Cost form I</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Cost form J</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Cost form K</td>
<td>2016/04/04</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Cost form L</td>
<td>2016/04/04</td>
</tr>
</tbody>
</table>

The Western University Health Science Research Ethics Board (HSREB) has reviewed and approved the above named study, as of the HSREB Initial Approval Date noted above.

HSREB approval for this study remains valid until the HSREB Expiry Date noted above, conditional to timely submission and acceptance of HSREB Continuing Ethics Review.

The Western University HSREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use Guideline for Good Clinical Practice (ICH E6 R1), the Ontario Personal Health Information Protection Act (PHIPA, 2004), Part 4 of the Natural Health Product Regulations, Health Canada Medical Device Regulations and Part C, Division 5, of the Food and Drug Regulations of Health Canada.

Members of the HSREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB.

The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

Ethics Office, on behalf of Dr. Marco Peramoncini, HSREB Vice Chair

Ethics Officer: Erika Basile, Joan Kaminski, Grace Kelly, Katelyn Harris, Viki Tran, Kern Gopal

Western University, Research, Support Services Bldg., Rm. 5150
London, ON, Canada N6G 1G9 t. 519.661.3036 f. 519.850.2466 www.uwo.ca/research/ethics
Appendix B: Letter of Information and Consent

Letter of Information

Study Title: A study to investigate the cost-effectiveness of a new referral pathway for total knee replacement (TKR)

Principal Investigators:
Robert Giffin, MD FRCSC
Fowler Kennedy Sports Medicine Clinic
3M Center
London, ON

Steven MacDonald, MD FRCSC
London Health Sciences Centre
University Hospital
London, ON

INTRODUCTION
You are being invited to participate in a research study because you are currently at your first consultation with the orthopedic surgeon at LHSC-University Hospital for your knee condition. To decide whether or not you want to be part of this research study, you should understand what is involved and the potential risks and benefits. This form gives detailed information about the research study, which will be discussed with you. Once you understand the study, you will be asked to indicate this on the consent form and begin the survey, if you wish to participate. Please take your time to make your decision. Feel free to discuss it with your friends and family, or your family physician.

PURPOSE
The purpose of this study is to compare costs and changes in health-related quality of life (HRQoL) among 2 groups of patients; 1) usual care, and 2) after the implementation of new-referral pathway. We have previously demonstrated that nearly 50% of patients referred to joint replacement specialists are not currently operative at the time of initial referral. The primary reasons patients were not booked for surgery after their initial consult include: patient unwilling to undergo surgery, patient lack of advanced disease progression and symptoms, patient had not yet tried conservative treatment (e.g. physiotherapy).

Given long wait times to access TKR, and the associated costs patients and the healthcare system incur related to these appointments, it would be advantageous to reduce the proportion of patients referred to TKR who are not suitable candidates at the time of referral. An electronic referral system that screens incoming knee referrals and provides education for patients and referring providers may help to reduce this proportion and improve access to care for suitable surgical candidates. This study will measure wait times, costs, and health-related quality of life outcomes throughout the usual referral and wait pathway (usual care), and then again after we implement the new e-referral pathway (NRP) as part of a practice change at LHSC.

The new referral pathway (NRP) is a web-based guided referral system that aims to screen referrals to TKR, providing patients and physicians with education to improve knee OA management, and to reduce the proportion of non-operative referrals to TKR. Decreasing the proportion of non-operative referrals may help reduce the total wait for surgery and associated costs.

DESCRIPTION OF STUDY
There will be approximately 600 patients enrolled in this study. The total time commitment for this study is variable based on individual wait times, and whether or not you proceed with surgery. Your participation will take approximately 20 minutes for each follow up. To participate in this study, you will need to provide an email address for the purpose of creating an account to access the study materials. If you do not have an email address, we encourage you to provide a family member’s email address who is willing to help you access the study materials. Also, if your email address contains your name or any identifiers, you may wish to create a new
email address for study purposes, although this is not required. You will receive an email reminder when you are required to complete forms, which must be completed online.

You are in the usual care group because we have not yet made changes to the way the referral system functions. If you choose to participate in this study, we will ask you to complete a series of online forms that query your basic demographics, general health, and your knee condition. We will also ask you to report your health related expenses online via standard forms. Completions of these forms are not part of usual care, and only pertain to your participation in this study. Whether or not you are booked for a total knee replacement at your first consultation, we will ask you to continue reporting your health-related expenses and HRQoL every 3 months up until 1 year after your first consultation. The length of the visit is not affected by your decision to participate in this study. This will conclude your participation.

**RISKS**

There are no known risks to your participation in this study. All patient and caregiver data will be secured, but there is a remote chance of a privacy breach, in which case patients will be immediately informed.

**BENEFITS**

There are no known benefits to you for participating in this study; however, this study will provide an in-depth understanding of the perspectives and experiences of both patients and health care professionals, providing valuable data to inform care decisions and improvements.

**CONFIDENTIALITY**

All information will be kept confidential to the best of our ability. Any personal health information collected or other information related to you will be coded by a unique number to ensure that persons outside of the study will not be able to identify you. In any publication, presentation or report, your name will not be used and any information that discloses your identity will not be released or published unless required by law. Despite these protections being in place, there is always a risk of unintentional release of information. The study personnel will protect your records and keep all the information in your study file confidential to the greatest extent possible. The chance that this information will be accidentally released is small.

The data that is collected from you is managed by a company called EmPower Health Research. Any information provided by you is protected by a username and password. It travels in a scrambled format to a server (storage computer) that is located in Montreal, Canada. Your email address and your date of birth are part of this database. The database will send automatic reminder emails to you if you are required to login and answer questions. Instructions for logging into the database will be provided by the research assistant. The company that houses the database is a professional company with extremely high standards of physical and virtual security. We want to let you know however, that even with this high level of security, there is always a remote chance that your information could be accessed or “hacked” by someone who is not supposed to have your information. If we became aware that this had happened, we would inform you immediately. We wish to make you aware that Dr. Bryant, who is one of this study's investigators, is the Director of EmPower Health Research. However, Dr. Bryant is not paid a salary by EmPower.

Study data will be kept for fifteen years. Representatives of the University of Western Ontario Health Sciences Research Ethics Board may require access to your study-related records or follow-up with you to monitor the conduct of this research. Representatives of Lawson Quality Assurance (QA) Education Program may look at study data for QA purposes.

**VOLUNTARY PARTICIPATION**

Participation in this study is completely voluntary. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time with no effect on your future care. Should you choose to withdraw from this study, we will keep all data obtained up to the point that you chose to withdraw.

Participation in this study does not prevent you from participating in any other research studies at the present time or future. If you are participating in another research study, we ask that you please inform us of your participation. You do not waive any legal rights by signing the consent form. If you would like to withdraw from this study, you will need to provide written or verbal confirmation to the study coordinator: Laura Churchill or Kate Lebedeva.
COST/COMPENSATION
There are no additional costs to you for participating in this study. There is no compensation for participating in this study.

CONTACT FOR QUESTIONS
If you have any questions about your rights as a research participant or the conduct of this study, you may contact Dr. David Hill, Scientific Director, Lawson Health Research Institute. For more information concerning this study and research-related risks or injuries, you may contact the Principal Investigator, Dr. Robert Giffin, at or the graduate student Laura Churchill, at or Kate Lebedeva, at

If you would like to receive a copy of the study results once they have been published, please indicate this on the letter of consent. Please be aware that the study results may not be available for up to 5 years. It is your responsibility to update your contact information with the researcher should it change. This letter is yours to keep for future reference. Thank you for considering participation in this study. We appreciate your time and interest.

Sincerely,
Dr. Robert Giffin, MD FCRSC, EMBA
Dr. Steven MacDonald, MD, FCRSC
Dr. Dianne Bryant, PhD
Laura Churchill, MPT/PhD (candidate)
Kate Lebedeva, MSc (candidate)

Letter of Consent

**Study Title:** A study to investigate the cost-effectiveness of a new referral pathway for total knee replacement (TKR)

I have read the Letter of Information, have had the nature of the study explained to me and I agree to participate. All questions have been answered to my satisfaction. I will maintain a copy of the LOI on the online database.

Completion of the baseline survey indicates your consent to participate.

☐ Yes I would like to participate and begin the online survey. Upon registering in the database, the system will send you an email with a link where you can go to set up your password.

☐ Yes, I would like to receive a copy of the study results once the study has been published.

☐ No, I am not interested in participating in this study.
Appendix B: Patient Questionnaires

Patient Demographics

<table>
<thead>
<tr>
<th>Date of birth: YYYY/MM/DD</th>
<th>Do you have symptoms in your other knee?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes  No</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Affected knee:</th>
<th>Gender:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right  Left</td>
<td>Male  Female</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dominant side:</th>
<th>Height: (feet, inches)  Weight: (pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right  Left</td>
<td></td>
</tr>
</tbody>
</table>

Are you willing to undergo TKA if you are an appropriate candidate?

- Definitely willing
- Probably willing
- Unsure
- Probably unwilling
- Definitely unwilling

If you indicated that you are unsure, probably unwilling, or definitely unwilling, why?

- I am a caregiver
- I don’t have anyone to care for me
- I’m afraid of making my condition worse
- Other (please explain):

Considering all the ways in which knee pain and arthritis affect you, how are you doing today?

0 1 2 3 4 5 6 7 8 9 10

Very well  Very poorly

Consider all the ways in which your knee pain and arthritis affect you. If you were to remain in your current state for the next few months, would you consider it to be satisfactory?

- Yes  No

Please indicate your current living status:

- Living alone
- Living with a spouse/partner
- Living with family (including extended family)
- Living with non-family (unpaid, including friends)
- Living with a paid attendant
- Living in a residential care facility
- Living in a hospital/long-term care/nursing home
- Other:

Are there stairs that you are required to use in your home?

- Yes  No

Have you previously had a joint replacement? If so, please indicate the joint(s) replaced.

- Right knee  Left knee  Right hip  Left hip
Healthcare Resource Use Questionnaire:
Tests, Procedures and Treatments Related to the Knee

Physiotherapy

Prior to being referred to us, have you tried physiotherapy to help with your knee?

☐ Yes  ☐ No, it was not recommended  ☐ No, but it was recommended – Why did you decide not to try it?

Please place a check mark beside all treatments that were used:

☐ Education on movements/positions to avoid
☐ Education on lifestyle factors (e.g., weight loss, exercise)
☐ Strengthening exercises (e.g., knee extensors, knee flexors, leg adductors, leg abductors)
☐ Stretching exercises
☐ Manual therapy (massage/manipulation of the knee)
☐ Electrical therapy (e.g., trans-cutaneous electrical stimulation [TENS], interferential current [ICF], biofeedback, neuromuscular re-education [NMES])
☐ Ice
☐ Heat
☐ Laser
☐ Ultrasound
☐ Acupuncture
☐ Orthotics (shoe inserts)
☐ Gait aid (e.g., cane, walker)
☐ Other: ____________________________

Describe the frequency and duration of your physiotherapy program (e.g., twice a week for two months).

How would you rate your compliance with the program?

☐ Perfect compliance  ☐ 75%  ☐ 50%  ☐ 25%  ☐ I didn’t comply

If you answered “25%” or “I didn’t comply”, why did you not comply with the program?

☐ Lack of time
☐ Lack of desire or motivation
☐ Too painful

Did you stop attending the program sooner than recommended?

☐ No  ☐ Yes – If yes, please provide a reason: ____________________________

☐ Yes – If yes, please provide a reason:
Chiropractic Therapy

Prior to being referred to us, have you tried chiropractic therapy to help with your knee?

☐ Yes  ☐ No, it was not recommended  ☐ No, but it was recommended – Why did you decide not to try it?

Please place a check mark beside all treatments that were used:

☐ Education on movements/positions to avoid
☐ Education on lifestyle factors (e.g., weight loss, exercise)
☐ Strengthening exercises (e.g., knee extensors, knee flexors, leg adductors, leg abductors)
☐ Stretching exercises
☐ Manual therapy (massage/manipulation of the knee)
☐ Electrical therapy (e.g., trans-cutaneous electrical stimulation [TENS], interferential current [ICF], biofeedback, neuromuscular re-education [NMES])
☐ Ice
☐ Heat
☐ Laser
☐ Ultrasound
☐ Acupuncture
☐ Orthotics (shoe inserts)
☐ Gait aid (e.g., cane, walker)
☐ Other: ____________________________

Describe the frequency and duration of your chiropractic therapy program (e.g., twice a week for two months).

☐ Perfect compliance  ☐ 75%  ☐ 50%  ☐ 25%  ☐ I didn’t comply

If you answered “25%” or “I didn’t comply”, why did you not comply with the program?
☐ Lack of time
☐ Lack of desire or motivation
☐ Too painful

How would you rate your compliance with the program?

☐ No  ☐ Yes – If yes, please provide a reason: ____________________________

Did you stop attending the program sooner than recommended?
Occupational Therapy

Prior to being referred to us, have you tried occupational therapy to help with your knee?

☐ Yes   ☐ No, it was not recommended   ☐ No, but it was recommended – Why did you decide not to try it?

Please place a check mark beside all treatments that were used:

☐ Education on movements/positions to avoid
☐ Education on lifestyle factors (e.g., weight loss, exercise)
☐ Strengthening exercises (e.g., knee extensors, knee flexors, leg adductors, leg abductors)
☐ Stretching exercises
☐ Manual therapy (massage/manipulation of the knee)
☐ Electrical therapy (e.g., trans-cutaneous electrical stimulation [TENS], interferential current [ICF], biofeedback, neuromuscular re-education [NMES])

☐ Ice
☐ Heat
☐ Laser
☐ Ultrasound
☐ Acupuncture
☐ Orthotics (shoe inserts)
☐ Gait aid (e.g., cane, walker)
☐ Other: __________________________________________

Describe the frequency and duration of your occupational therapy program (e.g., twice a week for two months).

How would you rate your compliance with the program?

☐ Perfect compliance   ☐ 75%   ☐ 50%   ☐ 25%   ☐ I didn’t comply

Did you stop attending the program sooner than recommended?

☐ No   ☐ Yes – if yes, please provide a reason:

Other Healthcare Professionals

Please indicate if you received treatment for your knee from the following providers prior to your referral:

Massage therapist   ☐ No   ☐ Yes
Osteopath   ☐ No   ☐ Yes
Acupuncturist   ☐ No   ☐ Yes
Pedorthist/Orthotist   ☐ No   ☐ Yes
Injections

Have you received an injection in your knee prior to being referred to us?

○ Yes  ○ No, it was not recommended  ○ No, but it was recommended – Why did you decide not to try it?

If you answered “yes”, please indicate the type(s) of injection(s) you received and who administered the injection(s). Check all that apply.

<table>
<thead>
<tr>
<th>Type(s) of injection(s):</th>
<th>Administered by:</th>
</tr>
</thead>
<tbody>
<tr>
<td>○ Corticosteroid</td>
<td>○ A surgeon</td>
</tr>
<tr>
<td>○ Hyaluronic acid (non-steroidal)</td>
<td>○ My family doctor</td>
</tr>
<tr>
<td>○ I’m not sure</td>
<td>○ An advanced practice physiotherapist</td>
</tr>
<tr>
<td>○ Other: _________________</td>
<td>○ A rheumatologist</td>
</tr>
<tr>
<td></td>
<td>○ I’m not sure</td>
</tr>
</tbody>
</table>

Conservative Treatments

Please select any of the following conservative treatments for your knee that you have tried on your own:

○ Lifestyle or activity modification

○ Weight loss (please indicate how many lbs. were lost): ____

○ Exercise
  ○ Aerobic exercise (e.g., walking, swimming)
  ○ Resistance exercise (e.g., leg raises, Thera-Band)
  ○ Stretching exercises
  ○ Other: _________________

○ Knee bracing

○ Specialized footwear (e.g., shoe inserts, prescription orthotics)

○ Topical NSAIDs (e.g., Voltaren)

○ Medications (prescription or over-the-counter)
Diagnostic Imaging Tests

Prior to being referred to us, have you undergone any radiological imaging tests to diagnose your knee pathology? Check all that apply and specify the results of the test, if known.

- **X-ray** – You may wear a heavy lead apron during the imaging. Typically, two or three images are taken.
  - Results: □ Mild/moderate osteoarthritis □ Severe osteoarthritis □ Unknown

- **MRI** – You lay flat on a narrow table, which slides into a large tunnel-shaped machine that produces loud banging noises. You may be given earplugs.
  - Results: □ Mild/moderate osteoarthritis □ Severe osteoarthritis □ Unknown

- **MRI arthrogram** – First, you are injected with a contrast agent or dye and then taken to the MRI scanner.
  - Results: □ Mild/moderate osteoarthritis □ Severe osteoarthritis □ Unknown

- **CT scan** – You lay flat on a narrow table, which slides into a round, donut-shaped scanner.
  - Results: □ Mild/moderate osteoarthritis □ Severe osteoarthritis □ Unknown

- **Ultrasound** – A lubricating gel is applied to your skin to help transmit the sound waves from a transducer throughout your body.
  - Results: □ Mild/moderate osteoarthritis □ Severe osteoarthritis □ Unknown

Medications

Prior to your referral, did you take any prescription or over-the-counter medications for any reason? Please check all that apply.

<table>
<thead>
<tr>
<th>NSAIDs</th>
<th>Analgesics</th>
<th>Anti-rheumatoid</th>
<th>Steroids</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Aspirin (ASA)</td>
<td>□ Regular strength</td>
<td>□ Plaquenil (Hydroxychloroquine)</td>
<td>Please list:</td>
</tr>
<tr>
<td></td>
<td>□ Extra strength</td>
<td>□ Aralen (Chloroquine)</td>
<td>1.</td>
</tr>
<tr>
<td>□ Celebrex (Celecoxib)</td>
<td>□ Arthritis</td>
<td>□ Arava (Leflunomide)</td>
<td>2.</td>
</tr>
<tr>
<td>□ Indocin (Indomethacin)</td>
<td>□ 1, 2 or 3</td>
<td>□ Methotrexate (Rheumatex)</td>
<td>3.</td>
</tr>
<tr>
<td>□ Advil (Ibuprofen)</td>
<td>□ Oxycodone/Acetaminophen (Percocet)</td>
<td>□ Azulfidine (Sulfasalazine)</td>
<td></td>
</tr>
<tr>
<td>□ Arthrotec (Diclofenac/Misoprostol)</td>
<td>□ Oxycodone (OxyContin)</td>
<td>□ Remicade (Infliximab)</td>
<td></td>
</tr>
<tr>
<td>NSAIDs</td>
<td>Analgesics</td>
<td>Anti-rheumatoid</td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------------------------------------------</td>
<td>----------------------------------</td>
<td></td>
</tr>
<tr>
<td>• Meloxicam (Mobicox)</td>
<td>• Tramadol</td>
<td>• Enbrel (Etanercept)</td>
<td></td>
</tr>
<tr>
<td>• Naproxen (Naprosyn/Aleve)</td>
<td>• Tramacet (Tramadol/ Acetaminophen)</td>
<td>• Humira (Adalimumab)</td>
<td></td>
</tr>
<tr>
<td>• Keterolac (Toradol)</td>
<td>• Hydromorphone (Dilaudid)</td>
<td>• Other (specify):</td>
<td></td>
</tr>
<tr>
<td>• Other (specify):</td>
<td>• Gabapentin (Neurontin)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Pregabalin (Lyrica)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Fentanyl</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Other (specify):</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Did you take any other medications prior to your referral?**  ○ No  ○ Yes

If yes, please list each medication, the date it was started and stopped (if you are still taking the medication, enter N/A), and if its cost was covered by OHIP, private insurance, or paid for out-of-pocket.

<table>
<thead>
<tr>
<th>Medication name</th>
<th>Date started (YYYY/MM/DD)</th>
<th>Date ended (YYYY/MM/DD)</th>
<th>Paid by</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td>OHIP Private insurance Out-of-pocket</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td>OHIP Private insurance Out-of-pocket</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td>OHIP Private insurance Out-of-pocket</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td>OHIP Private insurance Out-of-pocket</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td>OHIP Private insurance Out-of-pocket</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td>OHIP Private insurance Out-of-pocket</td>
</tr>
</tbody>
</table>
Cost Questionnaires

Emergency Room Visits and Hospitalizations

In the last 3 months, have you visited an emergency room for any reason?  ○ No  ○ Yes  

If yes, how many times? ______  
Indicate the reason for each visit: ____________________________________________  
What hospital did you go to for each visit? ______________________________________  

In the last 3 months, have you been admitted to the hospital for any reason, including overnight emergency room visits?  ○ No  ○ Yes  

If yes, please complete the following:  

| Admission date: ________  | Major surgery/procedure, if any: ________________  |
| (YYYY/MM/DD)              | Reason: __________________________________________|
| Discharge date: _________  | Hospital: ________________________________________|
| (YYYY/MM/DD)              | Discharged to: __________________________________|
| Days in the ICU/CCU: _____|                                             |

Family Doctor Visits

In the last 3 months, have you seen your family doctor for any reason?  
 ○ No  ○ Yes  ○ I do not have a family physician  

If yes, how many times? ______  
Indicate the reason for each visit: ____________________________________________  
How many of these visits were related to your knee? ______
Specialists Visits and Outpatient Clinics

In the last 3 months, have you seen a new specialist for any reason?  ○ No  ○ Yes
If yes, how many new specialists have you seen? ______
Specify the type of specialist(s) you have seen: __________________________________________
How many of these visits were related to your knee? ______
Where did you see each specialist?
○ Emergency room  ○ Private clinic
○ Hospital (outpatient)  ○ Rehabilitation center
○ Hospital (inpatient)  ○ Other: _____________

In the last 3 months, have you had any follow-up visits with a specialist for any reason?
Please include follow-up visits with surgeon who performed your knee replacement surgery.
○ No  ○ Yes
If yes, how many different specialists have you seen? ______
Specify the type(s) of specialist(s) you have seen: __________________________________________
How many follow-up visits have you had with each specialist? ______
How many of these visits were related to your knee? ______

Other Healthcare Professionals

In the last 3 months, have you seen any other healthcare professionals?  ○ No  ○ Yes
If yes, how many times have you seen a physiotherapist? ______
How many of these visits were related to your knee? ______
What was the cost of each visit? ______
How was this visit paid for?
○ OHIP
○ Private insurance
○ Out-of-pocket
How many times have you seen an occupational therapist? ____

How many of these visits were related to your knee? ____

What was the cost of each visit? ____

How was this visit paid for?

- [ ] OHIP
- [ ] Private insurance
- [ ] Out-of-pocket

Please indicate all other healthcare professionals you visited in the last 3 months in the table below:

<table>
<thead>
<tr>
<th>Health professional</th>
<th>Number of visits</th>
<th>Number of visits related to knee</th>
<th>Cost/visit</th>
<th>Paid by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acupuncturist</td>
<td>$</td>
<td>OHIP</td>
<td>Private insurance</td>
<td>Out-of-pocket</td>
</tr>
<tr>
<td>Massage therapist</td>
<td>$</td>
<td>OHIP</td>
<td>Private insurance</td>
<td>Out-of-pocket</td>
</tr>
<tr>
<td>Naturopath</td>
<td>$</td>
<td>OHIP</td>
<td>Private insurance</td>
<td>Out-of-pocket</td>
</tr>
<tr>
<td>Herbalist</td>
<td>$</td>
<td>OHIP</td>
<td>Private insurance</td>
<td>Out-of-pocket</td>
</tr>
<tr>
<td>Social worker</td>
<td>$</td>
<td>OHIP</td>
<td>Private insurance</td>
<td>Out-of-pocket</td>
</tr>
<tr>
<td>Home care/community nurse</td>
<td>$</td>
<td>OHIP</td>
<td>Private insurance</td>
<td>Out-of-pocket</td>
</tr>
<tr>
<td>Wound care specialist</td>
<td>$</td>
<td>OHIP</td>
<td>Private insurance</td>
<td>Out-of-pocket</td>
</tr>
<tr>
<td>Seating clinic therapist</td>
<td>$</td>
<td>OHIP</td>
<td>Private insurance</td>
<td>Out-of-pocket</td>
</tr>
<tr>
<td>Other:</td>
<td>$</td>
<td>OHIP</td>
<td>Private insurance</td>
<td>Out-of-pocket</td>
</tr>
</tbody>
</table>
**Tests and Procedures**

In the last 3 months, have you had any tests or procedures for any reason (e.g., x-ray, ECG, etc.)?

- O No  O Yes

If yes, check all imaging tests that apply:

- O X-ray
- O MRI
- O MRI arthrogram
- O CT scan
- O Ultrasound

Please list any other tests or procedures you had in the last 3 months in the table below:

<table>
<thead>
<tr>
<th>Other test/procedure</th>
<th>No.</th>
<th>% related to knee</th>
<th>Location of test/procedure (circle one)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td>ER</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td>ER</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td>ER</td>
</tr>
</tbody>
</table>
## Medications

In the last 3 months, did you take any prescription or over-the-counter medications for any reason? Check all that apply.

<table>
<thead>
<tr>
<th>NSAIDs</th>
<th>Dose (mg, g, etc.)</th>
<th>Pills/dose</th>
<th>Doses/day</th>
<th>Nº of days</th>
</tr>
</thead>
<tbody>
<tr>
<td>○ Aspirin (ASA)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Celebrex (Celecoxib)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Indocin (Indomethacin)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Advil (Ibuprofen)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Arthrotec (Diclofenac/Misoprostol)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Voltaren (Diclofenac)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Meloxicam (Mobicox)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Naproxen (Naprosyn/Aleve)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Ketorolac (Toradol)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Other:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analgesics</th>
<th>Dose (mg, g, etc.)</th>
<th>Pills/dose</th>
<th>Doses/day</th>
<th>Nº of days</th>
</tr>
</thead>
<tbody>
<tr>
<td>○ Tylenol Regular Strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Tylenol Extra Strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Tylenol Arthritis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Tylenol 1, 2 or 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Oxycodone/Acetaminophen (Percocet)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Oxycodone (OxyContin)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Tramadol</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Tramacet (Tramadol/Acetaminophen)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Hydromorphone (Dilaudid)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Gabapentin (Neurontin)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Pregabalin (Lyrica)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Fentanyl</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>○ Other:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Anti-rheumatoid

- Plaquenil (Hydroxychloroquine)
- Aralen (Chloroquine)
- Arava (Leflunomide)
- Methotrexate (Rheumatrex)
- Azulfidine (Sulfasalazine)
- Remicade (Infliximab)
- Enbrel (Etanercept)
- Humira (Adalimumab)
- Other:

<table>
<thead>
<tr>
<th>Steroids</th>
<th>Dose (mg, g, etc.)</th>
<th>Pills/dose</th>
<th>Doses/day</th>
<th>№ of days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Did you take any other medications in the last 3 months?**  
- No  
- Yes

If yes, please complete the table below:

<table>
<thead>
<tr>
<th>Medication name</th>
<th>Dose</th>
<th>Pills /dose</th>
<th>Doses /day</th>
<th>№ of days</th>
<th>Date started (YYYY/MM/DD)</th>
<th>Date ended (YYYY/MM/DD)</th>
<th>Paid by (circle all that apply)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>OHIP Private insurance Out-of-pocket</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>OHIP Private insurance Out-of-pocket</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>OHIP Private insurance Out-of-pocket</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>OHIP Private insurance Out-of-pocket</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>OHIP Private insurance Out-of-pocket</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>OHIP Private insurance Out-of-pocket</td>
</tr>
</tbody>
</table>
Supplies and Equipment

In the last 3 months, have you bought any supplies or equipment for your knee?

☐ No  ☐ Yes

If yes, please list all supplies and equipment and complete the table below:

<table>
<thead>
<tr>
<th>Supply/equipment</th>
<th>Cost</th>
<th>Obtained/purchased from</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hospital (outpatient)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hospital (inpatient)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rehab center</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other (specify):</td>
</tr>
</tbody>
</table>

Employment Status and Time off from Paid Work

Which of the following best describes your employment status or main activity when you were first referred to us?

☐ Retired
☐ Employed (full time)*
☐ Employed (part time)*
☐ WSIB*
☐ Accident Insurance*

☐ Disability*
☐ Litigation*
☐ Temporary sick leave from work*
☐ Self-employed*
☐ Government

☐ Homemaking
☐ Student
☐ Volunteer
☐ Social assistance
☐ Other: ____________

*What was your occupation? ____________________________

In the last 3 months, has your employment status or main activity changed?  ☐ No  ☐ Yes

If yes, which of the options listed above your current employment status? __________________________
Over the last 3 months, how much time off paid employment did you take as a result of your health (including hospitalizations, doctor/surgeon visits, treatment and rehabilitation)?

- Hours: ______
- Days: ______
- None

What best describes your annual household income?

- <$20,000
- $20,000 – 40,000
- $40,000 – 60,000
- $60,000 – 80,000
- $80,000 – 100,000
- >$100,000

In the last 3 months, how much time off from homemaking activities did you take due to your health (including days off because of hospitalizations, doctor visits, treatment and rehabilitation)?

- Hours: ______
- Days: ______
- None

In the last 3 months, how much time off from volunteer activities did you take due to your health (including days off because of hospitalizations, doctor visits, treatment and rehabilitation)?

- Hours: ______
- Days: ______
- None
# Assistance from Others

In the last 3 months, have you received assistance from a relative or a friend for healthcare, personal care, shopping, household activities or transportation?  ☐ No  ☐ Yes

If yes, please complete the table below. Select all that apply.

<table>
<thead>
<tr>
<th>Healthcare activities</th>
<th>☐ Taking medications</th>
<th>☐ Exercises/rehabilitation</th>
<th>☐ Other (specify):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Personal care activities</td>
<td>☐ Dressing/undressing</td>
<td>☐ Bathing/showering</td>
<td>☐ Going to the bathroom</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Shopping activities</td>
<td>☐ Shopping</td>
<td>☐ Meal preparation and clean-up</td>
<td>☐ Housework</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Transportation</td>
<td>☐ Doctor appointments</td>
<td>☐ Shopping</td>
<td>☐ Other (specify):</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Assistance Living

In the last 3 months, has your living situation changed?  ○ No  ○ Yes

If yes, was it related to your knee?  ○ No  ○ Yes

Please indicate your current living situation and the date that it changed in the table below:

<table>
<thead>
<tr>
<th>Current living status</th>
<th>Date of change (YYYY/MM/DD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>○ Living in own home – <em>no hired assistance</em></td>
<td></td>
</tr>
<tr>
<td>○ Living in own home – <em>hired assistance required</em></td>
<td></td>
</tr>
<tr>
<td>○ Living in relative’s home – <em>no hired assistance</em></td>
<td></td>
</tr>
<tr>
<td>○ Living in relative’s home – <em>hired assistance required</em></td>
<td></td>
</tr>
<tr>
<td>○ Supportive housing or personal care home</td>
<td></td>
</tr>
</tbody>
</table>

If you required hired assistance, please indicate the source of funding and the monthly cost.

○ Public-funded — *Cost/month: _____*
○ Insurance-funded — *Cost/month: _____*
○ Private-funded — *Cost/month: _____*

Did you incur any other expenses related to your knee that we have not asked you about? Please include the cost of gas, parking, food, etc.

○ No  ○ Yes

If yes, please list the expense(s) and approximate cost(s) in the table on the right:

<table>
<thead>
<tr>
<th>Expense</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
</tr>
</tbody>
</table>
Health-Related Quality of Life Questionnaires

WOMAC

**Symptoms and Disabilities** – Think about the pain you felt in your knee during the last 4 weeks.

<table>
<thead>
<tr>
<th>How much pain do you have...</th>
<th>None</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td>When walking on a flat surface?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When going up or down stairs?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At night in bed (pain that disturbs your sleep)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>While sitting or lying down?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>While standing?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Stiffness** – Think about the stiffness (increased difficulty in moving your joint, not pain) you felt in your knee during the last 4 weeks.

<table>
<thead>
<tr>
<th>How severe is your stiffness...</th>
<th>None</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td>After first waking in the morning?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After sitting/lying down/ while resting later in the day?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Difficulty Performing Activities** – Think about the difficulty you had in doing the following daily physical activities (moving around and taking care of yourself) during the last 4 weeks.

<table>
<thead>
<tr>
<th>How much difficulty do you have...</th>
<th>None</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td>When going down the stairs?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When going up the stairs?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When getting up from a sitting position?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>While standing?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When bending to the floor?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When walking on a flat surface?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When getting in or out of a car/a bus?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>While going shopping?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When putting on your socks?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When getting out of bed?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When taking off your socks?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>While lying in bed?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When getting in or out of the bathtub?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>While sitting?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When getting on or off the toilet?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>While doing heavy household chores?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>While doing light household chores?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
EQ-5D-5L Index

Please indicate which statement best describe your health state today by checking one box for each question.

1. Mobility
   - I have no problems in walking about
   - I have slight problems in walking about
   - I have moderate problems in walking about
   - I have severe problems in walking about
   - I am unable to walk about

2. Self-Care
   - I have no problems washing or dressing myself
   - I have slight problems washing or dressing myself
   - I have moderate problems washing or dressing myself
   - I have severe problems washing or dressing myself
   - I am unable to wash or dress myself

3. Usual Activities (work, housework, or leisure)
   - I have no problems doing my usual activities
   - I have slight problems doing my usual activities
   - I have moderate problems doing my usual activities
   - I have severe problems doing my usual activities
   - I am unable to do my usual activities

4. Pain/Discomfort
   - I have no pain or discomfort
   - I have slight pain or discomfort
   - I have moderate pain or discomfort
   - I have severe pain or discomfort
   - I have extreme pain or discomfort

5. Anxiety/Depression
   - I am not anxious or depressed
   - I am slightly anxious or depressed
   - I am moderately anxious or depressed
   - I am severely anxious or depressed
   - I am extremely anxious or depressed

EQ-5D Visual Analogue Scale
- We would like to know how good or bad your health is TODAY.
- The scale on the right is numbered from 0 to 100.
- 0 means the worst health you can imagine.
- 100 means the best health you can imagine.
- Please indicate on the scale how your health is TODAY.
Note that the phrasing of the healthcare resource questionnaire (pages 2–7 below) differed depending on the stage of care. New referrals and new consults were asked to report the use of conservative treatments and diagnostic imaging tests prior to their referral, whereas pre-surgical and long-term follow-up patients were asked to recall resource use since their initial surgical consultation.
Appendix C: Surgical Consultation Form

1. Did you order x-rays for this consultation?
   - No, the patient’s films were adequate
   - Yes, the patient’s films were not adequate
   - Yes, the films were not available to me

2. Is this patient an appropriate candidate for TKA based on his/her radiograph?
   - YES, this patient is appropriate. I would triage them in the following way:
     - **Priority Rating 1** – The surgical consult should have occurred sooner because:
       - Arthritis has been advanced for a long time with symptoms present
       - Other: ________________
     - **Priority Rating 2** – The surgical consult occurred at the appropriate time.
       Is this patient being booked for surgery?
       - Yes
       - No, because:
         - Patient is unwilling to undergo surgery
         - Patient has many comorbidities
         - Other: ________________
     - **Priority Rating 3** – The surgical consult could have waited because:
       - Arthritis is not advanced
       - Patient age
       - Patient occupation
       - Patient expectations
       - Insufficient symptoms
       - Patient has not yet exhausted conservative treatments (e.g. physiotherapy, injections, etc.)
       - Patient may be more appropriate for a sports orthopedic surgeon, and I am referring this patient to sports (e.g. for an HTO or scope)
       - Other: ________________
   - NO, this patient should not have been referred for TKA at this time because:
     - Arthritis is not advanced
     - Patient age
     - Patient occupation
     - Patient expectations
     - Patient has not yet exhausted conservative treatments (e.g. physiotherapy, injections, etc.)
     - Patient may be more appropriate for a sports orthopedic surgeon, and I am referring this patient to sports (e.g. for an HTO or scope)
     - Misdiagnosis (there is another cause for the patient’s symptoms)
     - Insufficient symptoms
     - Other: ________________
### Appendix D: Cost Estimate Calculations for Prescription and Over-the-Counter Drugs

<table>
<thead>
<tr>
<th></th>
<th>Prescription</th>
<th>OTC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coverage</strong></td>
<td>Ontario Drug Benefit Plan</td>
<td>Private insurance/ out-of-pocket</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>Amount MOHLTC pays $\times 1.08 + 8.83$</td>
<td>Drug benefit price $\times 1.1 + 10.69$</td>
</tr>
<tr>
<td><strong>Perspective</strong></td>
<td>Healthcare payer</td>
<td></td>
</tr>
</tbody>
</table>
Curriculum Vitae

Yekaterina Lebedeva, BHSc

Education

Master of Science
Health and Rehabilitation Sciences (Measurement and Methods Field)
Western University, London, ON
September 2016 – September 2018

Bachelor of Health Sciences (Honours)
McMaster University, Hamilton, ON
September 2012 – May 2016

Research Experience

Western University Graduate Student
Trends in Knee Arthroscopy Utilization – Identifying a Gap in Knowledge Translation
Supervisors: Dr. Alan Getgood, Dr. Ryan Degen, Dr. Dianne Bryant
2018

Western University Graduate Student
Wait Times, Resource Use and Patient-Reported Outcomes for Patients Referred for Total Knee Replacement Surgery
Supervisors: Dr. Dianne Bryant, Dr. J. Robert Giffin and Dr. Steven MacDonald
2016 – 2018

Western University Graduate Student
Optimizing Outpatient Total Hip Arthroplasty: Perspectives of Key Stakeholders
Supervisors: Dr. Brent Lanting and Dr. Debbie Laliberte Rudman
2017 – 2018

McMaster University Undergraduate Student
Treating Childhood Obesity and Type 2 Diabetes: Findings from an Interdisciplinary Workshop
Supervisor: Dr. M. Constantine Samaan
2015 – 2016

McMaster University Undergraduate Student
Canadian Study of Determinants of Endometabolic Health in Children (CanDECIDE)
Supervisor: Dr. M. Constantine Samaan
2013 – 2016
Publications


Work and Teaching Experience

University Hospital
August 2018 – Present

Research Assistant
Department: Sport Medicine & Orthopedics

Western University
January 2018 – June 2018

e-Learning Course Developer
Course: Critical Thinking in Quantitative & Qualitative Research
Supervisor: Dr. Dianne Bryant
Program: Graduate Diploma in Applied Health Sciences, Faculty of Health Sciences
Dean: Dr. Jayne Garland

Western University
Fall 2017

Teaching Assistant
HS 9788: Advanced Quantitative Research Methods
Professor: Dr. Dianne Bryant

Western University
Fall 2016, Fall 2017

Teaching Assistant
PT 9600: Introduction to Quantitative Research Methods
Professor: Dr. Dianne Bryant

Honours & Awards

Western University
2016 – 2018

Western Graduate Research Scholarship

McMaster University
2012

McMaster President’s Award

McMaster University
2012 – 2016

Dean’s Honour List