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A Model to Reduce The Proportion of Inappropriate Referrals to Surgery for Patients With Osteoarthritis: A Pilot Study

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A thesis submitted in partial fulfillment of the requirements for the Master of Science degree in Health and Rehabilitation Sciences
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A MODEL TO REDUCE THE PROPORTION OF INNAPROPRIATE REFERRALS
TO SURGERY FOR PATIENTS WITH OSTEOARTHRITIS: A PILOT STUDY

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by

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Graduate Program in Health and Rehabilitation Science

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Abstract

A significant proportion of patients referred for total knee arthroplasty are inappropriate candidates for surgery, which warrants remediation of the referral process to reduce wait times for the initial consult. We conducted a prospective feasibility investigation involving 166 patients referred from their general practitioner for a consultation with an orthopaedic surgeon at a joint replacement clinic. The aim of this study was to improve the validity of data collection forms and to improve the feasibility of collecting data in a clinical setting. We also wanted to strengthen our estimate of the sample size to inform the timeline. We were able to optimize patient recruitment strategy, refine data collection forms to improve their validity, and determined an adjusted sample size of 887 patients, based on our finding that 43% of patients were not suitable or willing surgical candidates. The planned large cohort study is feasible within 10 months.

Keywords

ii

Co-Authorship Statement

With the assistance of Drs. Bryant, Giffin, and MacDonald, we designed a prospective cohort study. We collaborated in the creation of the patient questionnaires and surgical consultation form, while I was solely responsible for identifying and recruiting patients; identifying issues, problem solving and implementing solutions. I wrote the original draft of the manuscript and Dr. Bryant made suggestions and comments that contributed to this thesis document. The thesis was sent to the other committee members for their comments and suggestions toward the final submission.

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Table of Contents

List of Tables

List of Figures

List of Appendices

Chapter 1

1 Introduction

Osteoarthritis (OA) commonly presents in the major weight bearing joints such as the knee and contributes to debilitating pain and impairments of physical function. One in eight Canadians (13%) suffer from OA.[1] Given appropriate candidacy, surgical treatment for end-stage knee OA such as total knee arthroplasty (TKA) and high tibial osteotomy (HTO) are highly successful with negligible risk.[2] Just as the population has aged over the past decade, so too has the demand for surgical treatment of OA resulting in long wait times across Canada.[3-6]

Cipriano et al. (2008) identified that wait times for TKA in Ontario are longer than clinically appropriate and that the demand for TKA is expected to increase. The current federal benchmark for wait times for these procedures is no longer than 6 months for low priority patients, while high and intermediate prioritized patients should undergo surgery 1 and 3 months from the time the decision for surgery has been made, respectively. These authors employed a discrete event simulation model of the Ontario joint replacement system, using information from the Ontario joint replacement registry (OJRR) to evaluate potential solutions to reduce wait times and improve management of waiting lists. Results of their simulation supported that clinically prioritizing patients once they were scheduled for surgery would reduce wait times for high priority surgical candidates, and ensure that more patients at each priority level received surgery in accordance with the maximum acceptable wait times. Moreover, their model indicated that the number of surgeries performed would need to increase by 12% annually over 10 years to ensure that 90% of patients received surgery within the federally acceptable wait time of 6 months. Alternatively a reduction in the demand for surgery could be employed to meet this mark by using explicit clinical criteria to "ration" surgeries offered.[7] One potential strategy to mitigate the demand for elective surgeries is to improve the referral process such that a greater proportion of referrals are reserved for patients who are truly considering surgery and are the most suitable candidates for TKA.

McHugh et al. (2011) found that patient referrals by general practitioners for consideration of TKA are often inappropriate as only 33% of patients referred by their general practitioner for TKA actually underwent surgery. The outcome of these patients consults indicated that the majority of patients referred back to their general practitioner were either not desiring of a surgical intervention at present, recommended for conservative management (physiotherapy, injections, weight loss), recommended for another surgical procedure (i.e. arthroscopy), directed to monitor the progression of OA, or no treatment was provided. This study highlights the role of general practitioners in the surgical referral pathway and suggests that referral should be limited to patients who are truly considering TKA, have exhausted conservative management and are appropriate candidates to undergo surgery. [8]

A more pragmatic look at the appropriateness of surgical referral was investigated in Ottawa, Ontario by Klett et al. (2012) who implemented an intermediate surgical screening clinic to determine the proportion of patients deemed eligible for further surgical consultation after initial referral by their general practitioner. Of the 327 patients assessed in the screening clinic, 155 (47.4 %) were referred back to their general practitioner. Common recommendations for patients referred back to their general practitioner were physiotherapy, bracing, injections, weight loss/ exercise, and medications. The authors suggested that strategies emphasizing appropriate referral may improve access to TKA. [9]

The combination of inappropriate patient referral by general practitioners and apparent usefulness of pre-screening before surgical consult, suggest that there is a need for greater clarity in the criteria for referral to an orthopaedic surgeon for knee OA. Thus the aim of the proposed study is to develop a model that best predicts clinical appropriateness for referral, identifying characteristics used by orthopaedic surgeons to decide that surgery is appropriate. We hope to then develop a model that best predicts: a) appropriateness for surgery; b) type of surgery most appropriate (joint replacement vs. alignment vs. other surgical procedures); and c) to design a referral pathway that provides education and guidance to the referring clinician. Education may include information about inappropriate and appropriate tests given signs and symptoms; how the results of different tests should influence the decision to refer; provide information about non-

operative interventions and how the patient's response to these interventions should influence the decision to refer; and patient characteristics to consider when making the decision to refer to an orthopaedic surgeon. The clinical significance of this work is to increase the efficiency of the referral process for surgical consultation for knee surgeries that are in high demand, which will ultimately afford faster access to care for patients who are suitable for surgery. This pilot study sought to investigate the feasibility of conducting the proposed research.

Chapter 2

2   Literature review

2.1   Anatomy of the knee joint

The knee joint is a complex synovial hinge joint, including the distal end of the femur, the proximal end of the tibia, and the patella. It is primarily involved in flexion and extension of the leg, although gliding and tracking movement occurs along its vertical axis. The bony articulation of the knee joint occurs where the distal end of the femur meets the proximal surface of the tibia, and where the posterior surface of the patella articulates with the femur. The articular surface of the tibia is made up of two fibrocartilaginous menisci that create depth in the joint and play an important role in shock absorption of bodily forces throughout the knee. The distal end of the femur is made up of lateral and medial femoral condyles that articulate with the corresponding menisci and condyles of the tibia to form the knee joint. [10]

Although the knee joint is considered a single unit it can be subdivided into 3 compartments: medial femorotibial, lateral femorotibial and patellofemoral. [11] During flexion and extension, articular cartilage of the femoral condyles, tibial menisci, and posterior surface of the patella allow the structures to glide as a unit. Congruence in this joint is highly dependent on this cartilaginous articulation and other structures such as the synovial membranes that lubricate the joint. Multiple surrounding ligaments also provide support to the highly unstable arrangement. [10]

2.2   The osteoarthritic knee

OA is a chronic joint disease, commonly affecting the weight bearing joints, characterized by a progressive degradation of articular cartilage. Conditions of an osteoarthritic joint include degradation of articular cartilage and subchondral bone, formation of osteophytes, synovial inflammation, and laxity of surrounding ligaments. [12] OA of the knee joint commonly presents unilaterally due to a degradation of meniscal and femoral cartilage of the affected side. [11] Patients with knee OA tend to bear more weight on either the medial or lateral condyle of the tibia creating a gradual loss of

articular cartilage and resulting varus or valgus knee malalignment. [13] OA most commonly affects the medial femorotibial compartment, resulting in distribution of forces through the medial aspect of the knee and subsequent varus malalignment. However, all three compartments may be involved as the disease progresses. Primary symptoms include pain, stiffness, decreased range of motion and functional limitations including symptomatic kneeling, squatting and stair climbing. [11]

2.3 Diagnosis

The diagnosis of OA involves both clinical and radiologic evidence. Symptoms such as chronic knee pain, stiffness, and joint crepitus are all indicators of early symptomatic OA. Physicians may also note abnormal findings on a clinical examination including bony enlargement of the knee, and narrowing of the joint space or osteophytes along joint margins on radiograph. However, many patients with radiological findings of joint OA do not present with symptoms of the disease and vice versa, which is why imaging is seldom used to diagnose the condition early on. Radiography is more commonly used as the gold standard to determine the severity of the condition in the osteoarthritic joint and monitor the progression of the disease. [14]

2.4 Treatment

2.4.1   Conservative treatment of osteoarthritis

Pain, stiffness, and loss of function of the joint are the primary reason sufferers of knee OA seek medical attention. [12,14] The use of non-operative strategies in the treatment of knee OA is regarded as the first course of treatment for symptoms before surgical management is considered. General practitioners' knowledge of conservative management strategies for knee OA is imperative to ensure that less invasive treatments have been exhausted and that referral for surgery is warranted. [14] VanManen et al. (2012) addressed several therapeutic strategies used in initial management of primary knee OA in their evidence-based clinical review. Primary management of knee OA encompasses pharmacological treatment such as the use of non-steroidal anti-inflammatory drugs (NSAIDs), and injections such as corticosteroid and hyaluronic acid (HA). Weight loss,

aerobic exercise, orthotics, osteopathic manipulative treatment and physical therapy are also utilized as non-pharmacological treatment of early symptomatic OA. [15]

In a Canadian study conducted by DeHann et al. (2007) the congruence between knee OA care in a rheumatology teaching clinic and current evidence-based treatment guidelines were investigated. One hundred and five patients with knee OA were randomly selected through chart abstraction and were inspected for use of conservative management strategies utilized. Results of this study indicated that the most commonly recommended non-pharmacologic treatment included: exercise (58.1%), physiotherapy (42.9%), and strengthening exercise (40.0%). Moreover, additional non-pharmacologic treatments such as education, aerobic and range of motion exercise, social support, orthoses, assistive devices for ambulation, acupuncture, and Occupational therapy/energy conservation were documented less frequently (in under 30% of patient charts), as recommended by current practice guidelines, suggesting underutilization of conservative strategies in managing knee OA. These results imply better strategies to educate and encourage physician adherence to current OA recommendations are needed. [16]

2.4.2   Surgical treatment of osteoarthritis

Surgical management of knee OA is utilized as a last recourse when moderate to severe pain and stiffness persists despite optimal conservative strategies, or if loss of function is severely debilitating. [12,17] The impact of disease on the patient's lifestyle is a crucial factor in informing the decision for surgery. In general, surgical intervention for knee OA is appropriate when the disease negatively impacts quality of life, limits activities of daily living, or impairs ability to sleep and work. [17]

The primary goal of both TKA and HTO surgical interventions are generally the same, including axis realignment of the knee, redistribution of load, improvement in mobility,

and pain relief. Although surgical interventions have similar goals, they should be utilized in different stages of OA and are indicated in different populations. [18]

In earlier stages of the disease progression, OA presents more commonly in the medial or lateral femorotibial compartments. HTO seeks to restore knee alignment, to slow the progression of cartilage degradation on the affected osteoarthritic compartment, and delay the need for total joint replacement. [12,19] In end-stage tri-compartmental OA a complete replacement of the articular surfaces, known as a total knee arthroplasty (TKA), is utilized to restore mobility in the joint and reduce pain associated with frictional forces. [12]

2.4.3   High Tibial Osteotomy

HTO is a surgical procedure used in treatment of knee OA often indicated in younger more active patients. The primary goal of an HTO is to correct either a varus or valgus alignment of the knee, which effectively unloads the affected osteoarthritic compartment. Valgus HTO is used to treat varus deformities and involves unloading of the medial compartment by means of a medial open wedge osteotomy or a lateral closing wedge osteotomy procedure [20]

By altering the weight-bearing axis of the knee, HTO is thought to slow the progression of OA by relieving undue stress on the deteriorating articular cartilage. [21] Surgical technique of the procedure aims to slightly overcorrect the abnormal tibio-femoral angle, in a varus or valgus position, as correcting the deformity back to its original structure would simply recreate the condition that led to the eventual malalignment. Thus, overcorrection is used to overcompensate for the adjacent muscle weakness lateral to the deformity. [2,13,21-23]

In a study by Naudie et al. (1999), lateral wedge closing osteotomy of 85 knees had survivorship of 51% at 10-year follow-up and 30% at 20-year follow-up. The authors suggest that given careful selection of patients and meticulous surgical technique survivorship in long-term follow up would be in the 60-95% range. [24] However, due to complications regarding the precision demands and structures within the knee, associated

with the lateral closing osteotomy technique, a medial opening wedge HTO is perhaps a superior, safer alternative. [25]

Further support for the medial opening wedge HTO technique was garnered by Birmingham et al. (2009) as they investigated gait, radiographic findings and patient reported outcomes with 2-year follow up in 126 patients with medial OA and varus alignment. Their results demonstrated that this particular procedure showed clinically significant improvements in patient reported outcomes and load reduction on the medial tibiofemoral compartment. [26]

McNamara et al. (2013) published a narrative review of patients with varus gonarthrosis who were managed with HTO at one sports medicine center in London, Ontario. The authors concluded that in terms of patient expectations HTO conversion to TKA is likely, and HTO is often a means to delay surgery while providing acceptable levels of activity and concomitant pain relief, not possible with TKA. [27]

Outcomes following HTO

A recent meta-analysis investigated the impact of high tibial valgus osteotomy on the treatment of knee OA compared to unicompartmental medial knee arthroplasty (UKA), in terms of survival, outcomes and complications. The review included 46 studies that investigated valgus HTO and 43 studies that involved UKA. The major aim of the study was to identify advantages and disadvantages of both procedures for treatment of moderate medial knee OA. The primary outcome measure of survival was defined as time until necessary revision to TKA. [19] Sphan et al. (2011) included six HTO studies that included 5-8 year follow up, nine that reported 10- year results, and two reported results beyond 12 years. Investigators were able to conclude that at 5-8 years 91% of the valgus HTO patients did not require a revision TKA, and within 9-12 years a substantial percent of patients (84.4%) did not require revision TKA. At greater than 12 years, 71% of valgus HTO patients still did not require revision. The overall complication rates (undefined) were pooled in 31 studies reporting HTO, indicating an effect size of 0.14 (P=0.37), demonstrating a low overall event rate of complications for either procedure. The major findings in this study assert that valgus HTO reports good outcomes and is a suitable

surgical treatment option for medial knee OA. The authors commented that HTO was a reliable procedure for avoiding TKA for up to 10 years and is indicated in patients who are younger, physically active, and are suffering from medial knee osteoarthritis. [19]

Moreover in a longitudinal observational study, Benzakour et al. (2010) assessed the 15-year results of 192 patients (224 knees) who underwent open (118) and closed (106) valgus HTO from 1982-2008. Overall patients experienced a relatively good outcome with HTO in terms of clinical and radiological results. After 10-15 year follow-up, clinical and radiological findings were shown to progressively deteriorate, thus the authors suggested that HTO should be viewed as a surgical option complementary to TKA. The authors concluded that medial opening wedge HTO is indicated for older patients at all stages of OA progression if a large correction is needed whereas a closing lateral wedge osteotomy for a moderate correction is more successful in younger patients. [28]

In their review of the HTO literature Amendola and Bonasia (2010) concluded that the ideal candidate for an HTO is a patient younger than 60 years old, with isolated medial OA and moderate range of motion, without instability of the surrounding ligaments of the knee. They also noted the negligible risk for conversion to TKA as none of the published data found statistically significant differences in outcomes of patients who had a conversion to TKA following an HTO or a primary TKA. [29]

2.4.4   Total Knee Arthroplasty

TKA is recommended in patients with severe knee OA with more than one compartment involved. The long-term success of TKA is well cited throughout the literature in terms of long term functional outcomes, prosthesis survival and minimal complications, which asserts this procedure as an optimal intervention for knee OA when patients fail to respond to more conservative management. [30-33] Currently TKA is the gold standard surgical intervention for symptomatic end-stage knee OA. While moderate severity knee OA is treated with a plethora of strategies ranging from conservative management to

alternative surgical interventions such as high tibial osteotomy, or unicompartmental medial knee arthroplasty (UKA). [19]

Predictors of TKA

There is a limited body of literature focused on identifying predictors of undergoing TKA, including the investigation of clinical factors and self-reported patient outcomes that predict undergoing TKA within a designated period of time. There are currently no studies that aim to predict appropriateness for HTO. Although the literature identifies which patients have favourable outcomes with both TKA and HTO procedures, there are no studies that concurrently assess how different patient factors and self-report measures predict suitability for the procedures.

Although there is no clear consensus on the indications for TKA among health care professionals, several studies have identified commonalities in those who undergo TKA compared to those who do not. These predictors are useful to identify patients who are appropriate surgical candidates. A prospective study conducted by Hawker et al. (2006) investigated the predictors of time to total joint arthroplasty (TJA) (which includes TKA and total hip arthroplasty) in two regions of Ontario, Canada. The study included 2128 participants from a pre-existing population based cohort with an average age of 71.5 years old (+/- 9.5) and median follow-up of six years. A variety of data was obtained via self-report including demographics, comorbidities, arthritis health, WOMAC, SF-36, BMI, and willingness to consider surgery. The primary outcome measure was the occurrence of undergoing either procedure, retrieved from hospital databases. Multivariate analysis indicated that significantly higher baseline WOMAC scores (HR 1.22/10 unit increase, P<0.001), increased age, better health (HR 1.14/10-unit increase in SF-36 score, P<0.001) and willingness to consider TJA (HR 4.92, P<0.001) were all predictors of time to surgery. Overall, the most significant predictor identified was willingness to consider TJA. The results of this study implicate the need for patient resources regarding the treatment of OA, in particular better education regarding indications, rehabilitation and outcomes of TJA. [34]

Similarly, Riddle et al. (2012) investigated factors associated with rapid progression to knee arthroplasty, defined as TKA within 3 years of baseline data collection. Baseline data was obtained from the Osteoarthritis Initiative (OAI) which is a cohort study funded by the National Institutes of Health with a database of 4796 patients who are at risk or have knee OA. Potential predictor variables included in the analysis were: demographics, socioeconomic characteristics, general health, arthritis health, results of physical examination, measures of physical performance and self-report pain and function. Prescreening of variables using univariate analysis was used to assess which factors may be associated with knee arthroplasty. From this analysis 31 potential predictors were significant and were input for further analysis using a multivariate statistical approach. Results showed that of the 4670 eligible patients included in the analysis, 116 patients underwent TKA from 2004-2008. Previously identified factors were found in the univariate model to be associated with future TKA including: considering TKA for either knee within the next 3 years (RR=25.83 CI 15.71-42.49), seeing a health care provider for arthritis (RR=3.65 CI 2.43-5.49), grade of OA severity (RR=3.61 CI 2.80-4.66), knee pain severity (RR=5.06 CI 3.48-7.37), global rating of knee pain (RR=1.30 CI 1.23-1.37), use of medication (RR=4.78 CI 2.75-8.30), care of an arthritis physician (RR=3.65 CI 2.43-5.49), and age (RR=3.61 CI 2.80-4.66). New variables were found including: self-report of past non-arthroplasty surgery (RR=4.94 CI 3.41-7.15), knee flexion contracture in degrees (RR=1.18 CI 1.13-1.23), and pain with active knee flexion (RR=5.06 CI 3.48-7.37). The authors commented that the investigation of predictors of TKA could allow for more informed patient decisions by comparing their own status with those who have had surgery. Riddle et al. (2012) suggested that these predictors of TKA could be a useful resource for patients considering the procedure. However based on the exploratory nature of the analysis, further confirmatory analysis would be needed to assess whether this model is fit in similar populations before these identified predictors could be used as adequate guidelines for patients and health care professionals. [35]

Conaghan et al. (2012) undertook a 3-year prospective study to identify clinical and ultrasonographic predictors of TKA. A cohort of 600 persons with painful knee OA were clinically evaluated and the rate of surgeries were determined over the study period.

Ninety-four patients underwent TKA. Several predictors were identified using a univariate log-rank test followed by multivariate analysis. Knee pain intensity on a 0-100mm visual analogue scale (•60 vs <60) (HR = 1.81 (95% CI 1.15-2.83), p=0.01), and disease duration greater than 5 years (•5 years vs <5 years) (HR=1.63 (95% CI 1.08 -2.47 p=0.02), were among the predictors identified that can be patient self-reported. Other clinical predictors identified were the Kellgren and Lawrence radiological grade (grade •III vs <III, hazards ratio (HR) = 4.08 (95% CI 2.34-7.12), p<0.0001), and ultrasongraphic knee effusion depth (•4 mm vs <4 mm) (HR = 2.63 (95% CI 1.70 -4.06), p<0.0001). A limitation identified by the authors was that they did not measure the role of psychosocial factors in predicting whether patients underwent TKA. Also, the relatively small proportion of patients that underwent TKA in this study likely limited the number of predictors included in their model. [36]

Zeni et al. (2010) investigated 120 persons with end-stage knee OA, defined as knee pain during ADLs, that prompted patients to consult an orthopedic surgeon, and a Kellgren Lawrence OA grade of >3. Subjects were followed over a period of two years to identify predictors of TKA. They found that younger age (p=0.002), greater performance on functional measures including the Timed Up and Go test (TUG) (p=0.03) and Stair Climbing Task (SCT) (p=0.01), and stronger quadriceps and full knee extension (p=0.01) were predictive of subjects who did not undergo TKA. Lower self-reported function on the Knee Outcome Survey-Activities of Daily Living Subscale (KOS-ADLS) (p=0.02) was predictive of those who underwent TKA. Cut-off points were calculated by analyzing Receiver Operating Characteristic (ROC) curves which determined that patients <60 years old, and patients with higher KOS-ADLS scores >50 were less likely to undergo TKA, while patients with knee extensor flexion >1 were more likely to undergo TKA. This investigation is limited in its small sample size and event rate of 40 subjects undergoing TKA in the 2- year period. Furthermore their study only investigated patients with end-stage knee OA, however TKA is not exclusively indicated in this population, as patients with moderate disease progression may require TKA as well. [37]

2.5 Lack of consensus of indications for surgery in knee OA

Despite common indicators in patients who undergo TKA, several studies comparing opinions of health care providers demonstrate a large discrepancy in indications for surgical referral for TKA. These studies highlight the general lack of consensus among health care professionals regarding conservative management and surgical treatment for knee OA.

An observational cohort study conducted by Wright et al. (1995) investigated the agreement among orthopaedic surgeons in Ontario in terms of their indications, usefulness, and outcomes of TKA. A survey was presented to the 325 practicing traceable surgeons in Ontario with a response rate of 72.%. The survey collected 234 surgeons' opinions regarding the usefulness of NSAIDs, physiotherapy, arthroscopy, synovectomy, osteotomy, hemiarthroplasty, and TKA. Orthopaedic surgeons were also asked to identify which patient characteristics modified their decision to perform a TKA. Finally, in a series of three hypothetical patients, surgeons were asked to recommend non-operative treatment, arthroscopy, osteotomy, UKR and TKA. Results indicated wide variation in the perceptions of usefulness of treatments for patients with moderate knee OA, suggesting that conservative strategies and surgical procedures were recommended differently among orthopaedic surgeons in Ontario. Respondents also disagreed on how patient characteristics would influence their decision to perform TKA. However, there was a consensus among orthopaedic surgeons that pain and functional disability were an important indication for TKA. Results suggested that although surgeons in Ontario are in general agreement on the usefulness of TKA in patients with end stage OA, discrepancy remains regarding surgeons' perceptions of the indications for TKA, treatment options, and outcomes of the procedure.[38]

Similarly, Mancuso et al. (1996) investigated the beliefs of orthopaedic surgeons in the U.S. regarding the candidacy of patients with OA for THA or TKA. Surveys were mailed to 327 practicing orthopaedic surgeons in New York City. The surveys included questions about indications, factors affecting outcomes, and what may modify the decision for surgery. Of the 122 orthopaedic surgeons who responded to the survey, 72 performed TKA. These respondents demonstrated agreement on several indicating factors

for TKA including: severe pain and transfer pain at least daily, rest pain several days a week, inability to walk more than three blocks, difficulty climbing stairs, joint space narrowing on radiographs, desire to be independent, and desire to return to work. Other factors such as age less than 50, comorbidity, alcohol use, obesity and psychological factors including depression, dementia, poor motivation, limited cooperation, and a hostile personality were indicated to deter the decision to recommend TKA. Results show that despite a majority of opinion among orthopaedic surgeons for several indications for TKA, a clear consensus was not evident. Potential explanation for this lack of consensus may be due to the multifaceted nature of surgical consultation and that individual factors may not be as important as weighing several patient and clinical factors concurrently.[39]

In a review article in 2006 that examined current indications for TKA the results of the aforementioned studies were highlighted and compared to similar studies. The indications for patient referral and undergoing TKA were examined, as well as contraindications for surgery among orthopaedic surgeons, rheumatologists, and primary care providers in order to assess how the nature of the physician affects decisions regarding indications for TKA. The results indicated that the only consistent indicator among and within all disciplines was "pain not responsive to drug therapy", and that in general there is minimal agreement for indications of TKA. It is interesting to note that orthopaedic surgeons were found to have more non-operative beliefs in comparison to referring health care providers, which suggests the importance surgeons place on exhausting conservative management before proceeding with TKA. The authors stated that better research on patient characteristics that predict the success of TKA are needed.[40]

In 2010, Cobos et al. conducted an observational cohort study that assessed the variability in indication criteria for TJA among 15 hospitals. Differences in surgeons' criteria for surgery were investigated by comparison of inter-hospital variation of TJA indication. The study included 1603 patients scheduled to undergo TJA and were recruited from waiting list databases between July 2005 and December 2006. Inter-hospital variation was determined using the weighted coefficient of variation in the 5 to 95-percentile range (WCV 5-95) for WOMAC and SF-12 scores of patients scheduled for surgery. Results demonstrated that certain indications for TKA had moderate to high variability among hospitals, such as "severe pain at rest"(WCV=0.40), "limping" (WCV=0.30), "need for

walking aids/wheelchair" (WCV=0.40). This variation suggests that surgeons utilized different clinical criteria when recommending surgery. A secondary objective of the study was to determine how many surgeries undergone were inappropriate according to clinical recommendations for TJA surgery (WOMAC score of 40 or lower), determined by Quintana et al. (2006). Results of the analysis showed that 250 out of 981 knee surgeries (25.5%; 95% CI: 22.8%-28.2%) were deemed inappropriate in accordance with this criterion. The variation in surgeons indication for surgery among hospitals and potentially inappropriate surgery for a quarter of patients suggests a lack of consensus exists, thus more explicit guidelines are needed in terms of which type of patients are suitable candidates for TKA. [41]

2.6 Appropriateness of Surgical Referral

It is evident that there is a general lack of consensus among surgeons indications for TKA. Based on the current literature available it is clear that patients are recommended for these surgeries for a variety of different reasons and these indications are often inconsistent. The lack of clear guidelines, especially for primary health care providers may play a role in the large proportion of inappropriate surgical referrals for TKA.

A practical look at the appropriateness of surgical referral was investigated in Ottawa, Ontario. In a study by Klett et al. (2012), the implementation of a screening clinic for patients referred for surgical consult was investigated to address long wait times for TKA. Participants were patients with knee OA referred by their general practitioner to the surgical screening clinic in a large teaching hospital in Canada. The intermediate surgical screening clinic was implemented to determine the proportion of patients deemed eligible for further surgical consultation and the proportion receiving subsequent surgery. Four sport medicine doctors in the screening clinic utilized the validated Western Ontario McMaster Osteoarthritis index (WOMAC) and the Western Canada Waitlist Hip and Knee Priority Criteria Tool (HKPT) to determine surgical eligibility and urgency. Retrospective chart review was used to determine common factors in patients who were deemed appropriate TKA candidates and who went on to receive surgery. Results indicated that out of 327 patients assessed in the screening clinic, 155 (47.4 %) were referred back to their general practitioner. Moreover, the 172 (52.6%) patients referred

onward to the surgeon, were significantly more likely to have tried injections (p<0.001), have tried three or more conservative management options (p=0.01) and had worse WOMAC and HKPT scores (p<0.001) than those referred back to their physician. Overall results from this study demonstrated that trained physicians' utilization of standardized screening tools in a surgical screening clinic would result in significantly less subsequent surgical consultations. Results also highlighted that conservative management strategies for knee OA are underused prior to surgical referral, emphasizing the importance of education about the initial conservative management of knee OA.[9]

Moreover, McHugh, Campbell, and Luker (2011) conducted a longitudinal observational cohort study to investigate commonalities between symptoms of patients recently referred by their general practitioners to receive total joint replacement. Patients were consecutively recruited from one regional orthopaedic center. All new referral letters to ten orthopaedic surgeons who had a confirmed diagnosis of OA and were considered potential candidates for TJA were eligible. Primary outcome measures included WOMAC score, demographic information, medication, OA management, and consultation outcome. Patient information was collected by questionnaire at baseline, three months, six months and twelve months. Results indicated that out of the 106 knee patients referred by their general practitioner who completed the baseline questionnaire, only 40 of the patients (37.7%) had subsequent TKA. This finding highlights the high rate of inappropriate referrals for surgical consult for TKA. Results indicated that patients with knee OA who were deemed eligible and underwent TKA had significantly worse baseline VAS pain scores (p=0.003), Oxford knee scores (p=0.001), baseline SF-36 physical function scores, and significantly worse WOMAC pain (p=0.03), stiffness (p=0.05) and physical function (p=0.04). The overall findings of this investigation maintain that in patients with knee OA, worse self-reported physical function and pain predicts subsequent TKA. This investigation also indicates that patient referral by general practitioners for consideration of TKA is often inappropriate as only 37% of patients referred by their general practitioner for TKA actually underwent surgery. This study emphasizes the role of general practitioners in the surgical referral pathway and suggests that referral should be limited to patients who are truly considering TKA and are appropriate candidates to receive surgery. A limitation of this study was that patients'

surgical eligibility was determined by 10 different orthopaedic surgeons, of whom criteria for selection is likely to differ, and that confidence intervals were not provided around point estimates, thus decreasing our ability to interpret the precision about the estimates.[8]

Aiken et al. (2008) research reported inappropriate referral for TKA and emphasis on the role of the physiotherapist in mediating referral to orthopaedic surgeons. The authors noted that the increasing demand for TJA places a burden on orthopaedic surgeons and this has lead to long wait times for surgical consultation and subsequent surgery in Canada. Thus the purpose of this study was to determine if physiotherapists could adequately fulfill the role of the orthopaedic surgeon in screening for TJA. Participants in this study included 40 patients who were referred to orthopaedic surgeons at a tertiary care center in Kingston, Ontario. Patients were first assessed by a single physiotherapist and subsequently by a single orthopaedic surgeon to determine surgical need and urgency using a standardized prioritization tool. Of the 40 patients 38 were analyzed, including 16 hip surgical candidates, 21 knee surgical candidates and one patient referred for both hip and knee surgery. Out of 38 patients, there was perfect agreement between the physiotherapist and orthopaedic surgeon, as 13 patients were deemed non- surgical by both health care professionals. These findings demonstrated the significant proportion (34%) of inappropriate referral for surgical consult and the usefulness of a physiotherapist to correctly identify surgical suitability. Based on these findings, the authors commented that a physiotherapist is an appropriate non-physician health care professional to screen patients for TJA. The use of physiotherapists to fulfill the screening role may subsequently decrease the burden placed on orthopaedic surgeons, by reducing the time they have to spend in clinics assessing patients that are not surgical candidates.[42]

It is evident that referral for TKA by primary health care providers to orthopaedic surgeons in Canada is often inappropriate as many patients are deemed ineligible for surgery after initial referral. Measures to ensure appropriate referral are needed across Canada and will surely help ease the demand placed on orthopaedic surgeons for these procedures. Moreover, the assurance of appropriate referral for surgical consultation will

reduce wait times to see a surgeon, thus providing appropriate patients with faster access to care.

The aforementioned studies address the high rate of inappropriate referral to orthopaedic surgeons for OA surgical interventions, but offer limited explanation as to why this discrepancy is occurring. Hudak et al. (2008) conducted qualitative focus groups querying a total of 17 orthopaedic surgeons, 15 rheumatologists and 18 physicians in Ontario to better understand how these health care practitioners determine patient candidacy for TKA. The authors suggested that many patients in Ontario were not offered surgery despite being medically appropriate candidates for the procedures due to constraints on resources and a process termed 'Medical Brokering'. The results from their in-depth interviews with participants shed light on the complex nature of referrals and suggested that physicians and surgeons were forced to act as intermediaries to choose the best candidates for these surgeries due to extensive wait lists, lack of operating room availability, and resources, all of which consistently influenced the decision making process. These constraints acted as barriers in which not all suitable surgical candidates were selected by surgeons to proceed with surgery. One surgeon in the study succinctly sums the issue stating, "everyone who needs one isn't going to get one"- in terms of TJA surgery. These findings suggest that appropriate referral is more complex than determining suitable candidates for surgery but is modified by characteristics prioritized by the operating surgeon and the current institutional constraints. The authors concluded that the lack of consensus for TJA indications was exacerbated due to these issues, and physicians must therefore act as medical brokers to determine the 'best' candidates for TJA rather than appropriate on an individual basis, adjusting their criteria to discriminate who warrants a surgical consult. Referring physicians thus are often unclear as to which patients are being prioritized by the surgeons they are referring to. This medical brokering may explain the high rate of inappropriate referrals from physicians to surgeons for these procedures and warrants a new system of referral guidelines for physicians and patients. [43]

2.7 Imaging

In efforts to improve the appropriateness of the referral for OA surgical interventions, the issue of necessary imaging for surgical consult is also of importance in managing wait lists. Appropriate imaging readily available for knee OA contributes to improving the quality of referral if a patient is indeed a suitable surgical candidate. Similarly the assurance that unnecessary imaging for knee OA is not utilized provides better assurance that clinical resources are being properly used for an increasingly prevalent condition.

The culmination of the second annual workshop on imaging in OA by the Osteoarthritis Research Society International (OARSI) led to the development of imaging guidelines published by Burstein and Hunter (2009). The authors confirm that radiography is currently recommended to determine joint space narrowing, therefore structural narrowing and disease progression should be determined by x-ray. However, they postulate that future research may suggest the usefulness of MRI to determine a more in depth look at structures within the knee to determine progression and early indicators of disease. Nevertheless, the preliminary promise for MRI in knee OA will need further validation. [44]

In a review by Hunter et al. (2011) of quality OA management and the need for reform, the authors suggest current practice in OA management is not necessarily reflective of current recommendations. The authors comment that often clinicians do not recommend the appropriate conservative treatment options, which leads to needless ordering of imaging, and referral to orthopaedic surgeons that is inappropriate. In terms of their guidelines for imaging for knee OA, Hunter et al. (2011) state that there is an overuse of imaging for a diagnosis that can be made clinically, and suggest radiography as a means to determine diagnosis when it is unclear, in order to negate other plausible causes of symptoms. Moreover, they comment that magnetic resonance imaging (MRI) should be sparsely used if at all, to rule out other potential causes of joint pain on an acellular level such as osteochondritis dissecans. The adoption of these principles may reduce costs and improve efficiency of care for knee OA. Overall the authors suggest directions for future research aimed at reducing existing patient and provider barriers to improve implementation of clinical guidelines. [45]

Lehnert and Bree (2011) investigation further supports Hunter et al. (2011) review as the appropriateness of MRI and CT scans were assessed retrospectively according to evidenced- based clinical guidelines of appropriateness. Results demonstrated that MRI for knee and shoulder OA with no previous trauma was among the most frequent inappropriate imaging services utilized. Specifically 5 out of 36 osteoarthritic knees and 7 out of 19 shoulders had previous inappropriate MRI, representing a proportion of 21% of OA patients in this study.[46] Although MRI is promising for extending our knowledge on the causes of OA because of its ability to detect contrast sensitive articular cartilage[47]in terms of diagnosis and surgical management, it is unnecessary to determine surgical suitability in OA patients and radiography remains the gold standard.[45]

Appropriate imaging readily available to orthopaedic surgeons will ensure that patients are ready to be assessed upon initial surgical consult. The assurance of appropriate imaging available upon consult will lead to a higher quality referral and subsequent better management of wait lists for knee OA. Strategies emphasizing expediting long wait times for surgical interventions for knee OA are among top priority in Canada as the prevalence of the disease continues to grow.

2.8   Wait times for surgical interventions
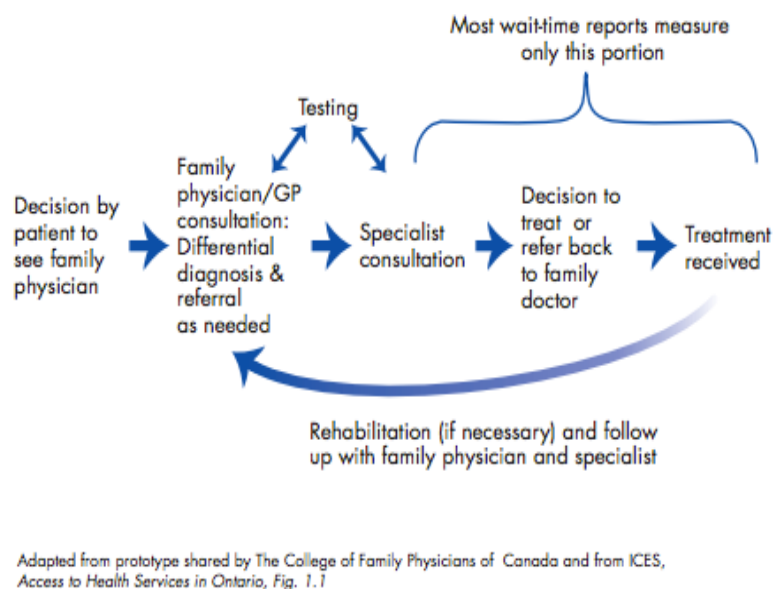
Figure 1. Wait times from a patient's perspective

Long wait times for TJA have a negative impact on the outcome of surgery and can negatively influence patient health, thus reducing wait times for these procedures should be priority in health care. In a longitudinal prospective study in Quebec by Desmeules et al. (2010), the impact of wait time for knee replacement surgery was investigated by measuring change in pain, function and health-related quality of life (HRQOL) during the pre-surgery period. Participants included 153 patients newly scheduled to undergo TKR surgery recruited from three university hospitals. The main independent variable was wait time defined as the time after surgery was scheduled to the actual date of surgery. Pain and function was measured by the WOMAC, and HRQOL was measured by the SF-36 at baseline and at time of surgery. Results demonstrated that during pre-surgery wait, significant deterioration occurred in WOMAC pain (-2.8; 95% CI -5.5, -0.19) and function (-4.6; 95% CI -7.7, -1.6), and physical functioning as measured by the SF-36 (-4.8; 95% CI -7.2, -2.4). These results implicate the importance of reducing wait times for

patients undergoing TKR due to the progression of pain and functional limitations seen in patients waiting for surgery. [48]

Fortin et al. (2002) investigated the predictors of outcome at long term follow up in patients with OA. In their prospective cohort study, for 165 OA patients undergoing hip or knee replacements, preoperative WOMAC and SF-36 scores were obtained and compared at two years follow-up to assess if preoperative pain and function influenced outcomes of surgery. The results of the multiple regression analysis showed that baseline pain and function scores were the best predictors of 2-year follow up scores, such that patients with worse preoperative scores showed less improvement after surgery than patients with better preoperative scores. These results imply the importance of timing in surgical procedures, as surgical intervention in the earlier stages of OA when pain and functional decline is not as severe, was shown to provide better outcomes at follow up. Thus, long wait times for TJA may hinder the delivery of surgery to patients before their disease progresses, resulting in poorer surgical outcomes. [49]

According to Canada's 2011 report card on waiting times for surgery, TKAs have the longest wait times in relation to the maximum acceptable wait time benchmarks (no longer than 6 months once the decision for surgery has been made), in comparison to the four other high-priority surgeries. Among the graded priority areas (Diagnostic imaging, TJA, radiation, cataract surgery, and elective cardiac bypass surgery), TKA has the longest wait times, with an overall nation-wide letter grade of 'C' indicating an average of only 60-69% of patients receiving surgery within the 6-month benchmark. Ontario is among the higher ranked provinces with 80-100% of the population receiving surgery within this benchmark, however it is important to consider these benchmarks are not meant to be utilized as an ideal target, rather they represent the longest clinically acceptable time a patient should have to wait for treatment. In response to the increasing prevalence of OA and high demand for surgical interventions such as TJA several government initiatives across Canada have been implemented to reduce wait times for surgery. [5]

Among these initiatives is the Canadian Joint Replacement Registry (CJRR). In collaboration with the Canadian Institute for Health Information (CIHI) and orthopaedic surgeons in Canada, the CJRR was developed and targeted reducing wait times for joint replacement as one of the top priority areas for federal funding. [50] In order to provide information to gauge these efforts the CJRR began collecting data in 2005, retrospectively obtaining wait times for patients who had already received hip and knee replacements. For data collection purposes in this registry, knee replacement was defined as any patient either having a TKR or a UKA. According to statistics from their data collection, a drastic 140% increase in the number of knee replacement surgeries occurred from 1996 (15,829) to 2007 (37,943). Wait times present a problem due to this remarkable increase in demand for knee replacement surgery. Despite the general trend of increasing wait times over the past decade, the CJRR notes that from 2007-2010 small gains have been made in reducing the number of days patients wait for TKA. Wait times for knee replacement surgery were 13 days shorter in 2006-2007 compared with 2005-2006 reports (median wait time of 169 days versus 182 days). Similarly, a reduction of 14.9 days was seen from 2007-2010 where wait times were reduced from 141 days to 128 days respectively. [51] Although these reductions are promising and reflect increasing efforts in Canada to improve access to TKA, the reduction of wait times in the CJRR reports are measured based on when the decision for surgery has been made until the patient undergoes surgery. Wait times as measured from time of referral from general practitioner to initial surgical consult also play a role in access to TKA (see Figure 1), thus this information would provide additional relevant information in monitoring improvements in access to TKA. Also the statistics of the CJRR are based on participating surgeons voluntarily reporting and thus cannot be assumed to be comprehensive.

In response to increasing demand for TJA, the Western Canada Wait List (WCWL) initiative developed a standardized surgical referral tool. The tool is intended for use by a primary health care physician to relay information to the orthopaedic surgeon to guide their prioritization of patients for surgery. The WCWL initiative focuses on the prioritization of patients once the decision for surgery has been made and does not take into account patient appropriateness for surgical selection. The use of the tool operates on

the assumption that all patients referred by their general practitioners are appropriate candidates for surgery as its sole function is to provide information on relative urgency.[52] The development of a system that incorporates appropriate patient selection and prioritizes patients in the queue for initial consult may provide a more comprehensive approach to wait list management.

Another Canadian based program that addresses the delivery of TJA was developed in Alberta, Canada. The overarching aim of the Alberta hip and knee replacement project was to create a new evidence-based clinical pathway (NCP) for TJA. This program sought to increase the efficiency of each stage in the referral pathway, without compromising patient care. Of particular interest were their efforts to improve the flow of patients from patient referral by general practitioner to an orthopaedic surgeon. To evaluate the effectiveness of the NCP, a randomized controlled trial was conducted in Calgary in which 3434 patients were allocated to either receive the NCP or conventional care. The main difference in referral process was that the NCP utilized a standardized referral tool for general practitioners and a single referral clinic instead of multiple referrals to different orthopaedic surgeons. Results of the pilot revealed that access to orthopaedic surgeons was significantly faster in the NCP group. The waiting time to see an orthopaedic surgeon beginning at the time of referral was significantly shorter in the NCP group (21 working days), compared to standard of care (145 working days). This preliminary research provides promising evidence that standardized referral measures may significantly improve access to surgery.[53]

2.9   Summary

With the prevalence of OA steadily increasing in Canada due to our aging population the demand for surgical interventions to aid these patients grows concurrently. OA commonly presents in the knee, and surgical interventions such as HTO and TKA are highly successful during different stages of OA progression in specific populations. Education is needed regarding the use of conservative treatment strategies before seeking surgical intervention as these strategies are often underutilized and could eliminate unnecessary surgical referrals if conservative management adequately alleviated patient symptoms. Diagnosis should not rely solely on radiographic evidence or clinical findings

upon examination but a complement of both. The combination of inappropriate patient referral by general practitioners, and usefulness of pre-screening before surgical consult with standardized referral measures, suggest that better referral guidelines and education for surgical interventions of knee OA are needed.

Patient factors that predict patient's eligibility and likelihood of undergoing surgical interventions are necessary in creating clear referral guidelines for general practitioners and patients with OA. Due to the general lack of consensus among health care professionals regarding indications for TKA and HTO procedures, and the inherent multifaceted nature of the referral and decision for surgery, better guidelines are needed to educate both patients and general practitioners regarding appropriate referral to orthopaedic surgeons. These guidelines will help to alleviate the burden on surgeons by decreasing the volume of inappropriate referrals for these procedures, while also ensuring patients faster access to care for surgical interventions that are increasingly in high demand.

Chapter 3

3   Objectives

The overall objectives of the proposed study are to develop a statistical prediction model to predict surgical appropriateness for patients with knee OA, type(s) of surgery most appropriate (TKA vs. HTO vs. other surgical procedures), and priority rating in the queue for initial surgical consult. Ultimately, this prediction model will serve to inform a web-based referral tool that will provide guidelines and education for patients and health care practitioners regarding appropriate timing for referral, offer education for the patient and family physician about appropriate imaging to be made available upon consult, conservative management strategies to exhaust before referral and indicators for surgical consideration. Ultimately this study will lead to a method to reduce the volume of inappropriate referrals to the surgeon thereby reducing wait times for patients who are well suited for surgical interventions by expediting their referral to a specialist and therefore the length of time they wait before the decision for surgery is made. This investigation requires data from a large prospective cohort of potential surgical candidates referred to orthopaedic clinics for problems associated with their knee.

The main objectives of this study were to explore the barriers to participation in this research study for a population of knee patients referred to a group of orthopaedic surgeons, to refine the study design to promote feasibility and validity of data collection in a clinical setting, and to determine the timeline and feasibility of recruitment in this population for the future large prospective observational cohort investigation.

The feasibility objectives were subdivided into: 1) Logistics; 2) Refinement of surgeon-reported data collection forms;3) Refinement of patient-reported data collection forms; 4) Factors influencing the sample size; and 5) Factors influencing the timeline including recruitment and completeness of data.

1) Logistics

The primary objective was to determine the most efficient way to administer the questionnaires and forms to patients and surgeons to ensure a high rate of participation, questionnaire completion and engagement.

Due to the large volume of potential participants projected, the logistics of adequately capturing information from all eligible patients given the current resources was of interest. Specific objectives included understanding the flow of patients through the orthopaedic clinic (x-ray, nurse, surgeon), the average time spent in each area, and to consider the most efficient and least disruptive time to work through the process of informed consent, registration of the participant in the web-based data collection system, teaching the participant how to use the data collection system, and having the participant complete a 30- minute questionnaire prior to their consultation with the surgeon.

2) Refinement of surgeon-reported data collection forms

The second objective of this pilot study was to gain feedback and refine the surgical consultation form completed by the orthopaedic surgeons post-consult. The surgical consultation form was specifically developed for this study, however its ability to adequately capture all potential outcomes of a participant's consult was unknown. Thus one of the goals of this pilot study was to better understand what criteria orthopaedic surgeons use to determine surgical appropriateness. These findings will ensure that the form is logical and response options are comprehensive and mutually exclusive for the larger cohort study.

3) Refinement of patient-reported data collection forms

We also evaluated the feasibility of the patient questionnaires. Specifically, we wanted to understand whether the length of the questionnaire would deter participation or completion of patient-reported forms and thus require a reduction in patient forms. Also we investigated whether certain measures were more commonly incomplete among participants and if this warrants refinement or removal of questionnaires.

4) Factors influencing the sample size

We explored preliminary findings regarding the appropriateness of the referral to estimate the sample size and to compare this estimate to the original projected estimation that was based on the reported rates in the literature.

5) Factors Influencing Timeline: Recruitment and Completeness of Data

We determined the proportion of new patients who were eligible for participation, the proportion of eligible patients who were willing to participate, and the proportion of consenting participants who completed their questionnaires. Questionnaires were considered complete if the questionnaire was fully complete or if a score for the outcome measure was adequately calculated despite missing data.

Chapter 4

4   Methodology

This was a single-center prospective cohort feasibility study conducted in London, Ontario involving patients attending their first consultation with an orthopaedic surgeon. The study took place in a high volume clinic that specializes in joint replacement, (approximately 50-80) new knee patients for consultation each week. The center performs 1,700 arthroplasty surgeries annually, which accounts for approximately three

percent of all arthroplasty surgeries performed in Canada annually.[3] Patients completed a series of questionnaires (Appendix C). Following their consultation, the attending surgeon completed a form detailing the outcome of the consultation (Appendix D). The study took place from April 2013 to June 2013 at the London Health Sciences Center (LHSC), University Hospital. The study was approved by the institutional Health Sciences Research Ethics Board (Appendix A).

4.1   Eligibility Criteria

Patients between 18-100 years of age, who were referred by their primary health care provider for their first consultation for surgical treatment of OA, were eligible to participate in this study. Patients were ineligible if they were non-English speaking or unable to complete the questionnaire due to psychiatric or cognitive impairment.

4.2   Subject Recruitment

All newly referred knee patients were identified by the study coordinator on the day of their scheduled surgical consultation and were invited to participate in the study after checking in for their appointment at the joint replacement clinic. For all new knee referrals the study coordinator recorded whether the patient met the eligibility criteria and agreed to participate in the study. If the patient consented to participate, the study coordinator registered the patient into the secure web-based data management system (EmPower Health Research, Inc, www.empowerhealthresearch.ca). Participants were provided with a unique username and password that would allow them to login and access the questionnaires. There was an iPad (Model A1219, © Apple Inc.) available in the clinic for patients to use or they could use their own web-enabled device.

The online questionnaires were completed in the waiting room during the time interval from when the patient checked in for their appointment with reception until they met with the surgeon for their appointment. Several studies have supported the validity of online data collection. [54-57] A Letter of Information (appendix B) was included as the first form in the online questionnaire and was presented to ensure patients' understanding that participation in the study was completely voluntary and that they were free to discontinue the study at any time. Initiation of the questionnaire was considered explicit consent for participation unless the patient opted to withdraw from the study.

4.3 Outcomes

4.3.1 Patient Questionnaires

Patients were asked to complete a series of questionnaires compiled for this study based on literature review and surgeon expertise. The questionnaires encompassed outcome measures and variables previously identified to predict undergoing TKA, as well as new measures that are potentially predictive of surgical recommendation. Measures querying patient's education regarding knee OA, and previous imaging utilized of their knee were also collected. Potential predictors were only included in the questionnaire if they could be self-reported. Thus previously identified clinically assessed factors and their association with future TKA were discounted in accordance with the overall aim of the study, to create a web-based guided referral system that can be utilized by patients and their general practitioner.

4.3.2 Demographics

We captured participants' age, gender, BMI, and occupation, since this information may influence the decision for surgery and predict undergoing TKA or alternative surgical interventions. In terms of occupation, the form detailed employment status, whether the participant's occupation requires repetitive knee motion, if they have had to reduce or modify their work duties because of their knee problem, and their desire to return to work and regain function to perform all work-related duties.

4.3.3   Arthritis Health

The arthritis health form detailed questions that we compiled to serve as potential predictors of appropriateness for TKA which included: previous conservative treatments on the study knee, number of years since diagnosis of knee OA, if the patient was currently seeing a doctor for arthritis, and history of past non-arthroplasty knee surgery. The form also included two validated measures, the Patient Acceptable Symptom State (PASS) for OA (in relation to ADLs, pain, and function), and a global rating of knee pain on a 0-10 scale from very good to very poor.

4.3.3.1 PASS

The PASS is a measure of acceptable clinical state and is defined as a measure to determine the threshold of symptoms and impairment, which a patient would consider manageable. This measure is useful in that the patient's perspective is taken into consideration to determine whether they are satisfied with their current state. A positive response to the PASS has shown to be correlated with moderate disease activity and pain measured by a visual analogue scale in the 30-35 mm range in patients with rheumatoid arthritis (RA). [58,59]

4.3.3.2 Pain NRS

A graphically delivered 11-point pain intensity- numeric rating scale (PI-NRS) is a common tool used in chronic pain studies which has been shown to be both valid and reliable for use in clinical research. [60] A minimal clinically important difference of two points has been demonstrated in populations with chronic pain including patients with OA. [61] The global rating of knee pain utilized was adopted from a previous prognostic study and differs from a traditional pain numeric rating scale such that it addresses pain and function more comprehensively by asking respondents to consider the effect of knee pain and arthritis in how they are managing in daily life. This format has shown greater predictive power in determining future TKA than a traditional pain NRS scale in a recent study. [35]

4.3.4   Lifestyle

We also included questions about the patient's lifestyle and primarily focused on sport participation. The form asks participants to indicate whether they participate in sport on a weekly basis, what level of sport they participate in, if their knee impairs them from their desired level of sport participation, and the importance they place on returning to sport after surgery and rehabilitation.

4.3.5   Willingness to undergo surgery

Subjects also completed questions about their willingness to undergo surgery, which was determined using a five-point likert-type scale where a participant was considered 'willing' if they selected the response 'definitely willing' or 'probably willing', and classified as 'unwilling' if they selected 'unsure', 'probably unwilling', or 'definitely unwilling'. If participants were unwilling, a follow-up question was asked to determine whether they believed their willingness to undergo surgery would change within the next three years.

4.3.6   Knee alignment self-assessment

We included a self-reported knee alignment instrument that asks patients to indicate the current angle of each of their legs in comparison to five line drawings ranging from varus (outward), straight, or valgus (inward) rotation. The tool has been developed and validated against radiographically assessed knee malalignment for use in questionnaire studies of knee pain and OA. The knee alignment self-assessment tool included in the questionnaire has been shown to be both valid and reliable in a population of patients with knee OA, demonstrating excellent sensitivity 0.74 (95% CI 0.54-0.93) and

specificity 0.97 (95% CI 0.94-1.00) and high patient reported reproducibility K=0.73 (95% CI 0.56-0.90). [62]

4.3.7 Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)

The WOMAC is comprised of three sections assessing pain, function, and stiffness and is scored based on a four point Likert-type scale, which is then transformed and totaled for each subscale as well as summed for an overall global score. The WOMAC has demonstrated excellent test-retest reliability in the pain and functions subscales, but consistently lower reliability coefficients in the stiffness subscale. The WOMAC has been found to have high construct validity with the SF-36 and various other measures in both TKA and non-arthroplasty knee surgery studies. Known groups validity of the WOMAC has been demonstrated in comparing different groups of TKA patients, which lends this measure to differentiate between groups based on external criteria. Finally, overall responsiveness of the WOMAC is excellent in patients undergoing TKA demonstrated by consistently large effect sizes. [63]

4.3.8 Knee injury and Osteoarthritis Outcome Score (KOOS)

The KOOS was developed as an extension of the WOMAC to improve its applicability to younger patients and to capture a broader range of functional activities ranging from leisure to basic ADLs, reflecting the increasingly younger and more active demographic suitable for TKA. The KOOS is a 42-item patient self-report questionnaire that is comprised of pain (9 items), other symptoms (7 items), function in daily living (17 items), function in sport and recreation (5 items), and knee-related quality of life (4 items). A KOOS score is calculated by transforming the 5-pt Likert scale to a 0-100 scale with 0 representing extreme knee problems, and 100 representing no knee problems. Each subscale of the KOOS is to be scored and interpreted separately. The psychometric

properties of the KOOS are well established in those undergoing TKA and patients with knee injuries. In these populations the KOOS has shown internal consistency for each subscale with a Cronbach alpha ranging from 0.76-0.93, and strong test-retest reliability with an ICC value greater than 0.70 for all subscales except for sport and function (ICC=0.65). The KOOS has demonstrated excellent construct validity relative to the WOMAC (r=0.90) and SF-36 ranging from (0.48-0.68). Finally it has been found to be highly responsive with a standard response mean SRM (>0.80) for each subscale. [64]

4.3.9   UCLA Knee Activity Score

The UCLA knee activity score was developed for patients undergoing joint replacement and seeks to obtain a single global activity rating. The UCLA has been used in clinical research by physicians and also patient self-reported. Patients are asked to classify their regular activity level in terms of frequency and intensity by selecting one of 10 response options that range from complete inactivity to regular participation in impact sports. The UCLA has demonstrated construct validity, as it is able to adequately discriminate between insufficiently and sufficiently active patients in 90% of TKA cases based on comparison with the International Physical Activity Questionnaire (IPAQ). It has also been shown to be reliable (K=0.86 in TKA patients), however small sample size may limit the strength of these conclusions. [65]

4.3.10   Charlson Comorbidity Index (CCI)

The Charlson Comorbidity index (CCI) is a measure that requires patients to indicate if they have been diagnosed with a wide variety of conditions deemed to contribute to an increased risk of patient mortality. The CCI assigns each condition a score (1, 2, 3, 6) that is totaled to generate a total risk of mortality. The conditions are weighted as follows: 1= myocardial infarct, congestive heart failure, peripheral vascular disease, dementia, cerebrovascular disease, chronic lung disease, connective tissue disease, ulcer, chronic liver disease, 2= hemiplegia, moderate or severe kidney disease, diabetes, diabetes with

complication, tumor, leukemia, lymphoma, 3= moderate or severe liver disease, 6= malignant tumor, metastasis, AIDS. The CCI has been validated to predict mortality such that increases in the level of comorbidity indices were correlated with stepwise increases in overall risk of mortality (log rank ^{2} = 165; p < 0.0001). [66] Support for the use of the CCI in a self-report questionnaire has also been displayed as self-reported Charlson indices predict 1-year mortality comparably with indices that are obtained from administrative data. [67] The CCI has been found to be predictive of complication rates following TKA therefore supporting its inclusion as an outcome measure in this study. [68]

4.3.11   Short Form 12-item Survey (SF-12)

The SF-12 is a subset of 12-items from the SF-36, used to assess general health related quality of life (HRQoL). The SF-12 queries eight health domains including: 1) physical functioning; 2) role-limitations due to physical impairment, 3) somatic pain 4) general health 5) vitality 6) social functioning 7) role limitations due to emotional problems, and 8) mental health. The first four domains are weighted and summed to obtain a Physical Component Score (PCS), while domains five through eight are weighted and summed to obtain a Mental Component Score (MCS). The measure has demonstrated criterion validity when compared to the SF-36. The measurement properties of the SF-12 were investigated as a measure of general health related quality of life in clinical trials with patients with OA. The SF-12 showed strong convergent validity with the SF-36 as 85-92% of the variability (R^2) in the PCS-36 and MCS-36 was explained by the PCS-12 and MCS-12, respectively. Further support for this measure's validity was shown as individual item-component correlations were confirmed within this population, demonstrating acceptable construct validity. [69]

4.3.12   Knee Society Score (KSS)

The knee society score (KSS) is a relatively new outcome measure that was developed and validated to improve the outdated knee society clinical rating system to incorporate

patient expectations, satisfaction, and physical activity based on the younger cohort of patients increasingly suitable for TKA. For this study a condensed version of the preoperative questionnaire was utilized such that only sections that could be patient self-reported were included. The KSS patient-reported section queried symptoms, patient satisfaction, expectations of TKA, and a variety of functional activities ranging from standard ADLs to advanced sport movements. Scores can be derived for each of the following subscales: 1) satisfaction, 2) expectations, and 3) functional activity. Preliminary findings have shown the measure to be applicable to a diverse range of patients and support its construct and convergent validity with the KOOS and SF-12 as well as reliability of the individual subscale measures. [70]

4.3.13 Hospital Anxiety and Depression Scale (HADS)

The HADS is a 14-item scale that generates an overall score for two subscales of anxiety and depression. It was developed as a patient-self report questionnaire to identify potential cases of anxiety and depression in non-psychiatric hospital settings. The measurement properties of the HADS have been investigated in patients suffering from somatic illness as well as the general population. Cut off scores of >8 for both anxiety and depression have been identified using ROC curves, which demonstrates the most optimal balance between sensitivity (0.83-0.90) and specificity (0.78-0.79) in both dimensions. Moreover, support for this measure's validity has been shown as it is well correlated with other commonly used mental health questionnaires (r=0.49-0.83). [71]

4.3.14 Oxford Knee Score (OKS)

The Oxford Knee Score (OKS) is a 12-item questionnaire, developed to measure health related quality of life in patients with OA that queries pain and physical disability using a five-point Likert-type rating scale with one point indicating no disability or pain, to five points indicating extreme pain and disability. The OKS produces a single score ranging from 12 (best functional outcome) to 60 (worse functional outcome). The OKS has

demonstrated good validity with moderate to high correlation with the WOMAC and KSS, excellent reliability with an ICC=0.91 (95% CI 0.82-0.95) [72] and a correlation between scores (r = 0.92) (p < 0.0001) in populations undergoing TKA. [73] Further, the OKS is sensitive to change (ES=2.19) in populations undergoing TKA, although one study showed its lack of specificity due to the influence of multiple pathologies on the absolute scores of the measure in TKA patients. [73,74] Ability of the OKS to detect change in populations with lower symptom severity (i.e. outpatients) is not as well established, however, preliminary work in a population of outpatients with knee OA demonstrated moderate to strong correlations between the OKS and Short Form -6 Dimension Health Survey (SF-6D) and European Quality of life- 5 Dimension Survey (EQ-5D) (r=0.51-0.82), supporting this measure's convergent construct validity. However, test-retest reliability and responsiveness have not been evaluated for its use in people diagnosed with OA. [75]

4.3.15   The Osteoarthritis Quality Indicator (OA-QI)

The osteoarthritis quality indicator (OA-QI) is a new 17-item self-report instrument that queries patient education, pain assessment, referrals, and pharmacological treatment in regards to their OA. The questionnaire seeks to determine quality indicator pass rates for patients with OA to monitor the quality of care received. The measure has demonstrated test-retest reliability with Kappa coefficients ranging from 0.20-0.80 (exact agreement ranging between 62-90%). The questionnaire has also demonstrated excellent construct validity with all 10 *a priori* hypotheses confirmed regarding its correlation with various outcome measures. [76]

4.3.16 The Intermittent and Constant Osteoarthritis (OA) Pain Score (ICOAP)

The Intermittent and Constant Osteoarthritis Pain (ICOAP) is a new 11-item tool developed to discriminate between constant knee pain and sudden intense bouts of knee pain, thought to be common in OA. The questionnaire is scored using a constant pain and intermittent pain subscale as well as a total pain score ranging from 0-44. This tool has not been previously investigated to determine whether constant versus intermittent pain scores play a role in predicting appropriateness for TKA. The tool has shown good internal consistency (Cronbach's alpha=0.80 for the constant score and 0.84 for the intermittent score). Test-retest reliability was poor (r=0.38, 95 % CI =0.03-0.68) in the intermittent subscale, whereas the constant pain subscale showed moderate reliability (r=0.76, 95% CI=0.53-0.89). The ICOAP scale has also demonstrated moderate-good correlation with the WOMAC pain subscale and adequate levels of responsiveness from pre- to postoperative TKA patients. [77,78]

4.3.17 Western Canada Wait List Hip and Knee Prioritization Tool (WCWL-HKPT)

The WCWL-HKPT is a tool developed by the Western Canada waiting list project that seeks to manage wait lists by setting priority scores for those awaiting TJA. The WCWL-HKPT is a seven-item tool intended for use by a physician and queries pain, function, abnormal clinical findings on physical exam, potential for progression of disease documented by radiographic findings, and threat to the patient's role and independence in society. For validation purposes the tool also included a 10cm visual analogue scale (VAS) measuring overall urgency for patient to receive surgery, to serve as the dependent variable in the regression analysis. The R^2 value was 0.68 (adjusted $R^2 = 0.68$), thus demonstrating that the priority criteria accounts for a large proportion of the variance in the clinician's urgency ratings. The tool has been validated for use by clinicians demonstrating good test-retest reliability (ICC=0.60-0.86) and inter-rater reliability (ICC=0.68-0.81). [79] Moderate correlations (r=0.45–0.56) of comparable WOMAC and priority criteria score items were found, demonstrating adequate construct validity. [80]

Select questions from the WCWL-HKPT were queried and are weighted as follows: 1) pain on motion (none/mild-0, moderate-6, severe-3); 2) pain at rest (none-0, mild-3, moderate-8, severe-11); 3) ability to walk without significant pain (over 5 blocks-0, 1-5 blocks-0, <1 block-4, household ambulator-7; and 4) other functional limitations (none-0, mild-4, moderate-11, severe-19). The full version of the WCWL-HKPT generates a score out of 100, whereas a score from 0-50 would be attainable using the select questions. The short form self-report version of the tool has not been validated.

4.3.18   Post-Consultation Surgeon Form

After the orthopaedic surgeon performed their usual consultation with the participant they completed a form detailing the outcome of the consultation. The form queried information about appropriate imaging (i.e. radiography) and whether the participant was an appropriate candidate for a TKA. The questions querying imaging required the surgeon to indicate whether the patient had x-rays ordered by the referring physician, and if so whether the x-rays included the preferred views (i.e. appropriate weight bearing films). If a patient was deemed an appropriate surgical candidate, a priority rating of 1-4 was assigned to their case based on the surgeon's relative judgment of the priority the patient 'should have' received for their consult. The surgeon selected one of the priority ratings out of the following: 1) The consult should have occurred sooner, 2) The consult occurred at the appropriate time, 3) The surgical consult could have waited, and 4) The surgical consult for this patient was unnecessary at this time. These urgency ratings were utilized to determine whether certain patient self-report measures were related to the urgency rating of the consult to obtain information to predict prioritization of patients in the queue for initial surgical consult. If the patient was deemed inappropriate for arthroplasty the surgeon indicated whether the patient would be more appropriate for an HTO and reasoning as to why this procedure would be more suitable. Finally, if the patient was deemed non-surgical the surgeon indicated this with reasoning provided as to why the patient was not a surgical candidate. This information will be used to investigate whether patient self-report measures can predict which type of patients are considered inappropriate surgical candidates, or are perhaps more appropriate for HTO.

4.4   Estimation of Sample Size

The limiting factor of research often lies in the feasibility of participant recruitment, as sufficient sample sizes are necessary to lend adequate precision to statistical results so as to make definitive clinical recommendations. Based on previous literature that identified 11 characteristics of surgical candidates, we proposed a sample size of approximately 800 patients would be necessary to achieve adequate power given the 35 predictors included in our model (Appendix G). This pilot aimed to determine the feasibility of recruiting this number of patients and the timeframe required to capture this large sample.

4.5   Plan for Statistical Analyses

To address our first objective, we collected time data for a week for all new knee referrals (n=29) in clinic by recording when the patient arrived at x-ray, when they checked in for their appointment in clinic, when they were called in by the nurse to the clinic room and when they checked out of the clinic.

To address our second objective, we welcomed suggestions from surgeons who were using the form and revised the form until the surgeons were satisfied with its usability and there were no further instances where participants were classified into more than one priority group.

To address our third objective, we determined patient willingness to participate based on the proportion of patients who agreed to participate and completed the questionnaire fully and we also welcomed suggestions and feedback from participants in terms of the applicability of the measures collected.

To address our fourth objective we analyzed the proportion of inappropriate patient referrals as classified by the surgical consultation form to determine the event rate to inform our projected sample size. We defined inappropriate referral as any patient who did not proceed with surgery after consult. Under these specifications patients were considered as inappropriate referrals if the surgeon indicated the outcome of the consult

as: 2. B) 'No this patient should not have been referred for arthroplasty at this time', 2.A) under priority rating 3- 'The surgical consult for this patient could have waited', or were within selection 2.A) indicating that the patient was indeed appropriate for TKA however they were not desiring of a surgical intervention. This definition of inappropriate referral was somewhat specific to our institution in that under this definition the proportion of inappropriate referral would be overestimated for orthopaedic surgeons whose practice is not as focused on TKA. In recognition of this, the rate of inappropriate referral was also calculated by excluding those patients who were deemed inappropriate referrals and indicated as more appropriate to be managed by a surgeon specializing in sports medicine (i.e. HTO/scope). This calculation provided a means to expand the applicability of our results to other practices.

To address our fifth and final objective we collected patient participation via a screening form where the status of all potential study participants was recorded.

Chapter 5

5 Results

One hundred and sixty-six patients participated in this study. There were 97 females (58%). The average age of participants was 62 +/- 11 years. Patient characteristics were typical of an orthopaedic clinic with a focus on joint replacement (Table 1).

Table 1: Patient Demographics

Characteristics	Eligible and completed questionnaire (n=127)	Eligible and partially completed/did not begin questionnaire (n=39)	Eligible but refused to participate (n=18)
Age (mean, SD)	62 (11) years	62 (15) years	71(10) years
Gender (number female, % female)	97 (58%)	25 (64%)	10 (56%)
BMI (mean, SD)	31.2 (6.6)	N/A	N/A
Employment status (type, %)	Retired= 68 (53.5%) Full time= 28 (22%) Part time= 8 (6.3%) Self-employed=10 (7.9%) Unemployed/ social assistance= 8 (6.3%) Stay at home caregiver =3 (2.4%) Student= 1 (0.8%) Volunteer =1 (0.8%)	N/A	N/A

N/A: This data was not collected for non-participants

5.1   Logistics

Wait times at the hospital for new knee referrals fluctuated greatly, depending on a variety of factors influencing the flow of patients. Among these factors were whether the attending surgeon had assistance from fellows and residents in assessing patients, the flow of patients in x-ray, and the volume of patients being booked for surgery. These factors made the feasibility of patients having sufficient time to complete the questionnaire unpredictable, thus online completion prior to the patient's appointment was determined the best option to optimize participation.

Thus, soon after starting the study, patients were recruited via telephone prior to their appointment. Participation was achieved using two different strategies. For those who agreed to participate online, the coordinator registered the patient on the online data management system, upon which the system instantly sent the participant an email with a link to set up their password. Upon logging into the system, the participant was presented with the Letter of Information. If the patient agreed to participate but did not have Internet access or if the patient could not be contacted prior to their appointment they were invited to complete the questionnaires when they arrived for their consultation prior to their appointment. In the clinic, participants could either enter their data directly online using an iPad (Model A1219, © Apple Inc.) or by completing a paper copy of the forms.

The majority of participants [128/166 (77.1%)] agreed to complete the questionnaire online. For participants who were unwilling or unable to complete questionnaires from home, alternative arrangements were made to have them complete forms using an iPad (Model A1219, © Apple Inc.) or via paper [38/166 (22.9%)], on the day of their appointment.

Insight was gained into the logistics of the hospital and joint replacement clinic, which helped inform the best method of recruitment for participants who were unable to complete the forms at home. Specifically it was determined that often patients wait for an extended period of time in the hospital x-ray department prior to checking in for their appointment at the clinic (Table 2). Thus for participants who were unable to access the

questionnaire at home or could not be contacted prior to their appointment, administering the questionnaires when they checked into their appointment for x-ray proved most feasible.

Table 2- Descriptive statistics of wait times for study participants on the day of their appointment

	Time spent in x-ray (minutes)	Time spent in clinic waiting room (minutes)	Time spent in clinic room (minutes)
(mean $\pm$ SD)	43 $\pm$ 23	37 $\pm$ 23	60 $\pm$ 22
Median	42	35	60
Range	103	74	105

Another adaptation to the study design was made as it was discovered throughout the pilot study that a proportion of inappropriate referrals from general practitioners were pre-screened by the surgeon's administrative assistant (i.e. never considered by the surgeon), or by the surgeon and returned to the referring clinician (never receiving an appointment with the surgeon). This discovery prompted the addition of a new form (Appendix E) to adequately capture these participants so that they could be included into the analysis.

5.2 Refinement of Data Collection Forms: Surgeon Questionnaire

During the pilot study several changes were made to the surgical consultation form based on feedback from the attending surgeons. The form was modified as in some cases, the outcome of a patient's consult either did not fall under a designated category within the form, or placed a participant in more than one category. The form was modified to ensure that common outcomes of a participant's consult could be adequately documented in a logical way, and ensured participants could not be considered for more than one category, for purposes of data analysis.

Originally the question 'Did this patient have x-rays done that were ordered by the referring physician?' only had the response options 'yes' or 'no', however a third response option, 'unknown', was added to the forms because it was often unclear whether the referring physician or the hospital ordered the imaging. Similarly, for the follow up question, 'Did the series of x-rays include the preferred views? (i.e. appropriate weight-bearing films)', a response option indicating 'unknown' was added as the participating surgeons indicated that often they are unable to determine whether or not the radiographs presented were weight-bearing films because the films often lack sufficient labeling.

The form was also modified to ensure that participant's priority rating was mutually exclusive, i.e. patients could not logically fall into more than one category. Selection A) on the original form was edited to remove priority rating 4 as a response option ('The surgical consult for this patient was unnecessary at this time'), as this was deemed to be redundant with the response option B ('No, this patient should not have been referred to arthroplasty at this time'). Also within selection A) the priority ratings were further expanded to provide reasoning for each priority based on common reasons that the surgeons' cited which would have warranted that a consult occurred sooner or later than it did. If a participant was determined priority rating 1, 'The surgical consult for this patient should have occurred sooner', a follow up question was added to provide reasoning. It was determined that the primary reason for selecting this response option was because the patient's arthritis had been advanced and symptomatic for an extensive period of time. Because of the frequency of this response, we added this to the list of

response options to reduce the number of open-ended responses, which can present challenges during analyses.

Priority rating 2, which indicates that the surgical consult for the patient was at the appropriate time, also required refinement. Specifically, in several cases, despite the surgeon feeling that the patient was appropriate for surgery, the patient opted out of undergoing the procedure. This prompted the addition of a follow up question that required the attending surgeon to indicate whether the appropriately referred patient was being booked for a TKA, and if not, to provide a reason(s). Response options of 'patient not desiring of surgical intervention', and 'too many comorbidities' were added as common reasons for appropriate surgical candidates, referred at the appropriate time, to not proceed with a surgical intervention.

Priority rating 3: 'The surgical consultation for this patient could have waited', was modified to include opportunity to add an explanation. The following response options were added: lack of advanced arthritis, patient age, patient occupation, patient expectations, insufficient symptoms, patient has not had sufficient conservative management (e.g. PT, injection etc.), patient is more appropriate for a surgical consult with a sports surgeon who performs HTO or scopes.

Finally, the last two response options B) 'No this patient should have never been referred for arthroplasty but is appropriate for an HTO' & C) 'No this patient is not a surgical candidate' were consolidated into one selection. The wording was refined as in the original form a patient could reasonably fall into both categories. The response options were combined into one selection 'No this patient should not have been referred for arthroplasty at this time', with multiple response options including the option to indicate that the patient is more appropriate for a sports surgeon. We also captured whether in fact, these patients were actually referred to a sports surgeon (i.e. to FKSMC).

All of the modifications to the surgical consultation form were cumulated to create a form (appendix F) that is more logical and includes opportunities to add reasoning for response selections to gain valuable information about why participants were considered either

appropriately or inappropriately referred to an arthroplasty clinic. The modifications also ensure that participants can only logically be classified into one category, which will help to simplify the analysis of the data and allow for a meaningful logistic regression to be employed to identify predictors of appropriateness for future model building purposes.

5.3 Refinement of Data Collection Forms: Patient Questionnaires

There was a high rate of completion of the questionnaire among study participants (76.5%) thus we did not remove any outcome measures. However, it was noted that some items were often not applicable to participants who were classified as an inappropriate referral. Specifically within the KSS, there is a section asking the subject to comment on their 'expectations for their knee replacement surgery', which assumes that all subjects were expecting to receive a recommendation for TKA; which they were not. Given this insight, we preempted the original willingness question with a new question asking participants their perception of why they were referred (i.e. due to knee OA or a different knee injury), as well as a question asking the participant to specify their willingness to undergo a total knee replacement, with the option to select 'I don't believe my problem requires a total knee replacement'.

Finally we reordered the presentation of the outcome measures based on our perception of the importance of each outcome in case the participant became fatigued and did not complete all questionnaires or that they were unable to complete the entire questionnaire prior to consult. Thus, the order reflected the perceived importance of the potential predictor and questions or questionnaires whose responses may be influenced by the subject's interaction with the surgeon. The revised order is as follows: 1) Demographics, 2) Willingness to undergo surgery, 3) OA-QI, 4) HADS, 5) KOOS, 6) KSS, 7) ICOAP, 8) UCLA, 9) Knee alignment self-assessment, 10) WCWL-HKPT, 11) Oxford knee, 12) Arthritis health, 13) Lifestyle, 14) SF-12, 15) Medication form, and 16) CCI.

5.4 Factors Influencing the Sample Size

Of the 166 participants, 40 were deemed inappropriate (24%). There were a variety of reasons for this classification and often multiple concurrent reasons as to why the participant was considered an inappropriate referral including, insufficient symptoms (n=9), insufficient conservative management (n=9), misdiagnosis (n=12), being more appropriate for a sports orthopaedic surgeon to manage (n=11), lack of advanced arthritis (n=15), patient expectations too high (n=4), patient age (n=4), and patient occupation (manual labourer, n=1).

The remainder of participants who were deemed appropriate surgical candidates for TKA were distributed among the priority ratings as follows: Priority rating 1 (the surgical consult should have occurred sooner): 16/166 (9.6%) and Priority rating 2 (the surgical consult for this patient was at the appropriate time) 88/166 participants (53%). However, of the 88 participants classified as Priority 2, 11 were not booked for surgery including 10 patients who did not want a surgical intervention and one patient deemed a complex case needing further evaluation before the decision for surgery could be made.

Priority rating 3 (the surgical consult could have waited) was indicated for 22/166 participants (13%) due to insufficient symptoms to warrant surgical intervention (n=7), insufficient conservative management (n=12), or that the patient was not desiring of a surgical intervention at present (n=5).

In terms of refining the estimation of sample size, the 10 participants that were appropriately referred in terms of surgical need for arthroplasty, but who did not desire a surgical intervention were included in the overall proportion of inappropriate referrals. Similarly, participants indicated as priority rating 3- 'the surgical consult could of waited', were included in the proportion of inappropriate referrals because although these patients were appropriately diagnosed as having knee OA, the consult occurred

prematurely and the patient was not booked for surgery. Priority rating 3 thus implies inappropriateness, due primarily to the timing of the referral or a lack of exhaustive conservative management. Under these specifications 72/166 (43.4%) of participants were defined as inappropriate referrals because they were either not surgical candidates for TKA, did not desire surgery, or were not ready or optimized for surgical intervention at the time they were referred. If the surgeons at this center also dealt with sports injuries an adjusted proportion, 61/166 (36.7%) of referrals would be considered inappropriate.

The adjusted sample size was calculated based on these preliminary findings. The total number of predictors to be included in the model is 35. Ensuring 10 events per predictor requires 350 events according to Peduzzi rule of thumb. [81] Thus, using the limiting event rate of 72/166 (43.4%) inappropriate referrals, a sample size of 887 participants will provide sufficient power for analysis (assuming 10% attrition). Based on the number of participants recruited within 8 weeks (166) the projected sample size is likely attainable within a data collection time span of 9 months assuming recruitment remains constant at an average of 20 participants per week. Furthermore, a larger sample size of approximately 1000 patients would be needed to explore an analysis generalizable to other practices.

5.5 Factors Influencing Timeline

5.5.1 Recruitment

From April 17, 2013 to June 7, 2013, a total of 228 patients were screened for eligibility. Of these, 44 did not meet eligibility requirements, while 18 eligible patients elected not to participate (see Figure 2). An additional, seven patients were referred to the arthroplasty clinic and were pre-screened by the surgeon (or their administrative assistant) and referred to a sports medicine orthopaedic surgeon at FKSMC without ever receiving an appointment with the arthroplasty surgeon.

Among the 166 eligible patients that agreed to participate, 39 participants either did not fully complete (n= 18) or begin the questionnaire (n=21). The outcome of their consult was still collected and reported in the overall results.

Results indicated an overall rate of participation among eligible new knee referrals of 90.2 %. The rate of completion among participants was relatively high with 76.5% of participants fully completing the questionnaires. Among the non-participants, 9.8% of eligible patients refused to participate, 9.6% of all patients assessed for eligibility were deemed ineligible, 6.1% were either incorrectly included or missed due to error, while 3.5% did not show up for their scheduled appointment.

Among those who were eligible but chose not to participate, the most commonly cited reasons included: disinterest in completing additional non-mandatory paperwork, lack of desire to participate in research, lack of desire to divulge personal information for research purposes, and lack of time to complete questionnaire due to the timing of their appointment. Overall, there were 39/184 (21.1%) eligible non-participants.

Figure 2: Flow of patients through the study
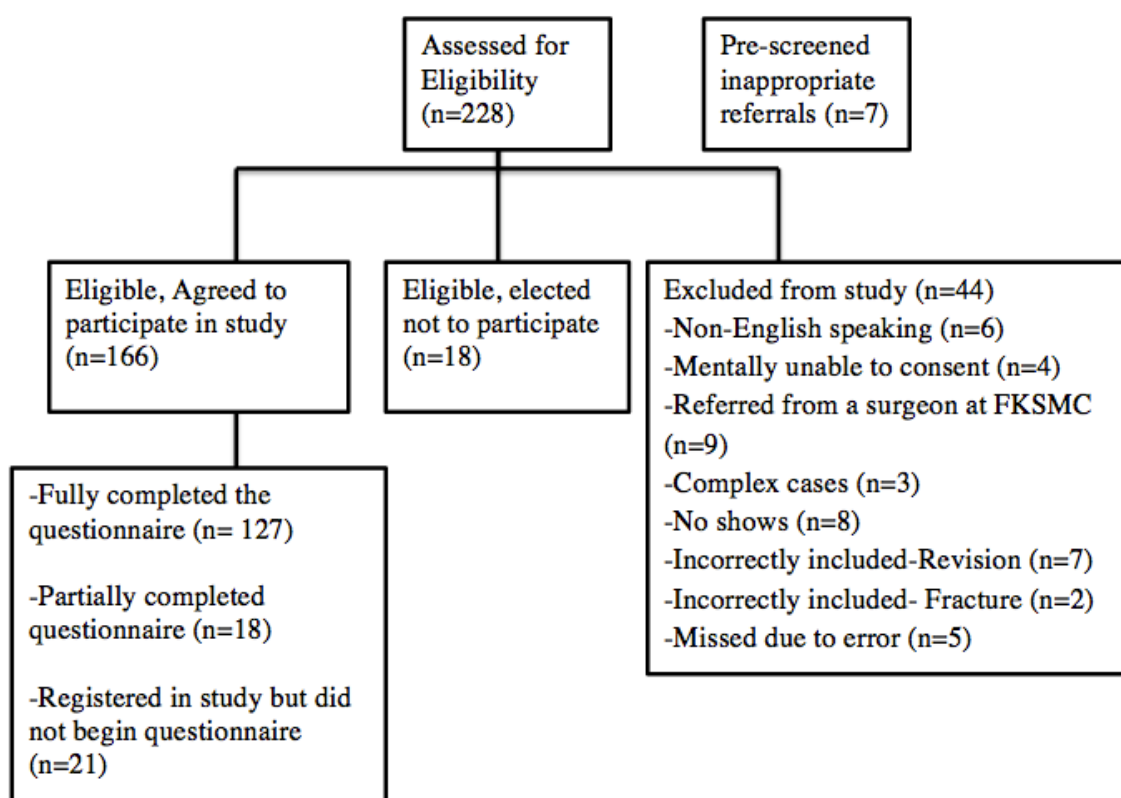
5.5.2   Completeness

Among study participants, 39/166 (23.5%) of patient forms were considered incomplete. Eighteen of the 166 (10.8%) participants partially completed the questionnaires, while 21/166 (12.7%) of participants agreed to complete the questionnaires but failed to provide any responses. Among the 39 patients with incomplete forms, there was not a specific measure that was consistently outstanding (see Figure 3).

Figure 3: Frequency of incomplete outcome measures
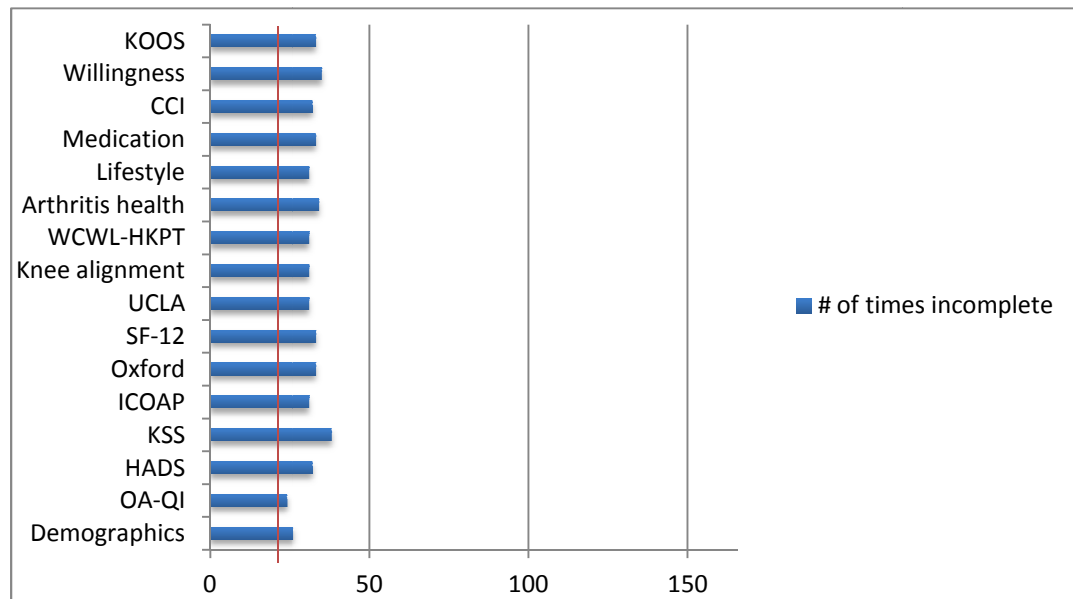
Chapter 6

6   Discussion

The primary objective of this pilot study was to assess the logistics and feasibility of a large prospective cohort study to inform a web-based referral and education tool for general practitioners and patients considering referral to surgery. We improved our protocol, data collection forms, and were able to better inform our estimate of sample size and timeline for the full study. We discovered that there are a large proportion of referrals for TKA that are inappropriate. We also found that approximately 10% of referrals for TKA were for patients who had severe OA with extremely advanced symptoms who, in the opinion of the surgeon, should have been referred sooner. Both findings support the need for a guided referral system that includes education for the patient and referring physician.

We found that approximately 37% of consults were either inappropriate or premature (i.e. the patient lacked advanced OA, was only mildly symptomatic or had not yet tried or exhausted conservative treatment such as physical therapy or injections to manage their OA). This suggests that non-surgical management for knee OA is underutilized and that education regarding conservative treatment options could reduce the number of inappropriate consults.

We also found that approximately 6% of patients referred for joint replacement were not ready to proceed with surgery. McHugh et al. (2009) found that 7 patients of 21 (33%) surveyed did not follow through with their orthopaedic surgeon's recommendation for surgery. In a qualitative interview with a subsample of these patients, four themes were identified: feeling like they would rather cope with the symptoms than have the surgery; negative opinion of family or friends toward surgery; misconceptions about the risks associated with surgery; and seeking a second opinion.[82] Thus an important piece of physician education is to encourage a frank discussion between themselves and their patient about the patient's willingness to undergo surgery before the referral to surgery is made.

It is also probable that the referring physician feels that it is the role of the orthopaedic surgeon to present patients with the resources, options, and their recommendation regarding surgery. We feel however, that it is important that the primary physician feels confident in making the diagnosis of knee OA, determining the severity of OA, administering/prescribing/managing a non-surgical treatment plan, and describing surgical options to their patient. Providing physicians access to a web-based resource that describes the process of making a diagnosis, conservative management, and surgical options may increase their confidence. Providing a resource directed to patients that includes much of the same information, commonly asked questions, and patient experiences may better inform patients so that they are requesting a referral at a more appropriate time and can participate in decision making.

By attempting to reduce the number of unnecessary surgical consults we present a way to reduce part of the total wait times for TKA by reducing the wait for the initial surgical consult. Ensuring patients the fastest access to care is important, particularly in a degenerative disease such as OA, where patients' deterioration, including increased pain and reduced function, significantly affects their quality of life.

It is important to note that a significant proportion of patients (approximately 57 %) were referred appropriately for TKA by their general practitioner and booked for surgery after initial consult with the surgeon. Collecting information regarding what type of patients are appropriate candidates for surgery will inform referral guidelines for surgical consideration for knee OA.

We also identified a small proportion (n=8) of patients who did not show up for their consultation. Eight patients did not receive another booking while three patients failed to show up more than once. The number of missed appointments during the study period totaled 13/ 219 or just fewer than 6% of new knee appointments. None of these patients called to inform the clinic that they would not be attending the appointment, which meant that other patients waiting in the queue for first consultation were not given an earlier appointment. In our study, we did not investigate the reasons why patients did not show up for their appointment, thus it is not possible to suggest means to reduce this proportion. Though we realize that there will always be last minute reasons why patients

do not show up for their appointment, we are also aware that physicians often refer their patients to more than one surgeon and that perhaps the patient received an appointment with another surgeon. In terms of structuring the web-based referral system, it may be important to include a small description of the volume of patients waiting for consultation and the importance of calling well in advance if an appointment must be missed or if the patient is no longer interested in the consultation. Using a web-based system would provide the opportunity to have a system that automatically sends an email to the patient to remind them of their upcoming appointment and allows the patient to confirm or cancel their appointment within the email. Our study found that 77% of participants had an email address, which speaks to the feasibility of this management option.

One discovery that was unexpected was that some of the surgeon's administrative assistants were screening referrals and if inappropriate were returning the referral to the primary physician with suggestions as to who might be more appropriate to handle the referral (e.g. sports medicine). We also learned that each surgeon pre-screens their referrals and re-directs any that are more appropriate for another specialist. We made this discovery about half way through (a month) into the pilot study and only one of the seven surgeons' administrative assistants kept these referrals so that we could go back and include them in our numbers. Because we could not accurately produce this number for all surgeons, we did not include them in the analysis for the pilot study. However, including the numbers from just one surgeon inflates the proportion of inappropriate referrals during this pilot investigation from 43.4% to 45.7%. If similar proportions are observed among the other surgeons' referrals, the proportion of inappropriate referrals could approach 60%, which would actually exceed the proportion of referrals that are appropriate.

Despite the length of the questionnaire, patients generally responded favourably to participating in this study likely due to the simplicity of their involvement, as it generally did not delay or interfere with their appointment and the questionnaire being the only requisite of their participation, with no additional follow up requirements. We discovered

early on in recruitment that patients were more likely to complete questionnaires if we called them ahead of their appointment and allowed them the opportunity to complete questionnaires at home, on their own time, when they were not distracted by meeting the obligations of a first time consultation (e.g. registration, x-ray, other patient questionnaires, seeing the nurse, residents, fellows, and the surgeon). Despite this, there were still 18 patients (approximately 11%) who provided only partially complete data because they ran out of time while at clinic and did not wish to remain following their consultation to complete their questionnaires. There was an additional 21 (13%) who gave their consent, were registered in the system, were asked during their clinic visit to complete questionnaires, but did not ever start the questionnaires. These patients were of similar age to patients who fully completed their questionnaires. There was an additional 18 (11%), who were eligible for participation but who would not give their consent. These patients tended to be older (71+/-10 years) than participants (62+/-11 years). Thus, in terms of applicability, approximately 30% of eligible patients would not be represented by our findings. This is similar to other studies in this population.[8]

Although participation rates did not necessarily warrant the removal of any measures to condense the questionnaire, the number of participants that have partially complete forms incited a reordering of the forms within the questionnaire. The new order of forms included first, those most likely to be influenced by information provided during the consultation (i.e. 'willingness to undergo surgery' and the OA-QI), followed by those unlikely to be influenced (e.g. Charlson Comorbidity Index). We considered condensing the questionnaire to minimize the burden on patients however, the lack of pre-existing definitive evidence as to the predictors of TKA warrants including a wealth of predictors from which to construct our predictive model.

A limitation of this study is that the results are highly specific to this center and population. Our study center is unique in that it is a group of surgeons dedicated to arthroplasty who operate almost exclusively in their designated specialty. Thus the rate of inappropriate referral may be slightly overestimated in comparison to referrals to an orthopedic surgeon who deals with a broader spectrum of diagnoses. For example, if the

surgeons at this center also dealt with sports injuries the rate of inappropriate referrals would be lower (61/166 (36.7%). Alternatively, because our center is sub-specialized in arthroplasty our rate of inappropriate referrals may not be completely comprehensive as we are not able to consider referrals made to a sports surgeon that are inappropriate for sports and better suited to be managed by a surgeon specialized in arthroplasty. However, we expect our rate of inappropriate referral may be underestimated given these considerations. Despite this, the results from our pilot study shed light on the current need for general practitioners to play more of an active role in reducing wait times for TKA. A potential intervention is to have the web-based guided referral system select the appropriate surgeon given the diagnosis of the patient. To broaden its applicability the web-based guided referral system can be built in such a way that it can (first and foremost) predict whether the patient is a willing surgical candidate and then, if applicable refine its classification by diagnosis and direct the referral based on the expertise at each center.

Chapter 7

7   Conclusion

This pilot study discovered that a large proportion of referrals for TKA from the general practitioner are inappropriate under our parameters. We demonstrated that the proposed large prospective cohort study is feasible owing to the high volume of patients seen at this center for surgical consult for knee OA, and the high rate of participation among eligible patients. The refinement of the protocol and data collection forms that occurred over the course of this study will ensure that the future investigation will encompass a fairly representative sample of this population. Finally, the large projected sample size in the future study will inform a model that can be validated and has the potential to universally inform the decision to refer to surgery for knee OA.

Appendices

Appendix A: Ethics Approval Form

Western Research

Research Ethics

Use of Human Participants - Ethics Approval Notice

Principal Investigator: Dr. Robert Giffin
File Number: 103374
Review Level: Delegated
Approved Local Adult Participants: 1000
Approved Local Minor Participants: 0
Protocol Title: Predicting outcome of surgical consultation for TKA and HTO
Department & Institution: Schulich School of Medicine and Dentistry\Surgery,Western University
Sponsor:
Ethics Approval Date: April 15, 2013 **Expiry Date:** September 30, 2013
Documents Reviewed & Approved & Documents Received for Information:

Document Name	Comments	Version Date
Instruments	Form for orthopaedic surgeon to fill out after surgical consultation for HTO with study participants.	
Instruments	Form for orthopaedic surgeon to fill out after surgical consultation for TKA with study participants	
Western University Protocol		2012/12/30
Instruments	Revised forms for the online survey	2013/01/30
Revised Letter of Information & Consent	Revised LOI FKSMC clean	2013/04/14
Revised Letter of Information & Consent	Revised LOI LHSC clean	2013/04/14
Amendment	Response to REB Comments	2013/04/09

This is to notify you that The University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the Health Canada/ICH Good Clinical Practice Practices: Consolidated Guidelines; and the applicable laws and regulations of Ontario has reviewed and granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above. The membership of this REB also complies with the membership requirements for REB's as defined in Division 5 of the Food and Drug Regulations.

The ethics approval for this study shall remain valid until the expiry date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the University of Western Ontario Updated Approval Request Form.

Members of the HSREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the HSREB.

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

Ethics Officer to Contact for Further Information

This is an official document. Please retain the original in your files.

Western University, Research, Support Services Bldg., Rm. 5150
London, ON, Canada N6A 3K7 t. 519.661.3036 f. 519.850.2466 www.uwo.ca/research/services/ethics

Appendix B: Letter of Information

London Health Sciences Centre

Caring for You. Innovating for the World.

Title of Research: Predicting outcome of surgical consultation for TKA and HTO

Principal Investigators:

The purpose of this letter is to provide you with the information you require to make an informed decision about participating in this research.

You are being invited to participate in a study to investigate the predictors of the need for surgery. We are asking you to take part because you have been referred for a surgical consultation for total knee arthroplasty (TKA).

If you agree to participate, you will be asked to complete an <u>online</u> survey detailing information about yourself, including demographics, occupation, willingness to undergo surgery, psychological health, comorbidities, lifestyle, and your personal identifying information (name, mailing address, email address, phone number, hospital identification number and your date of birth). The questionnaire also asks about your knee problem such as: including arthritis health, medication information, and various knee-related self-report measures. The online questionnaire is expected to take 20 minutes of your time. 1000 patients are expected to participate in this study. Completion of survey indicates consent to participate. Your answers to the questionnaire go into a database. The confidentiality and security of this database is discussed below.

<u>Compensation:</u>
There are no costs to participating in this study.

<u>Risks:</u>
There are no known risks to your participation in this study. Participation is voluntary. You may refuse to participate, refuse to answer any questions or discontinue the survey at any time with no effect on your future care. Should you choose to discontinue the survey, we will keep the data you have contributed to that point. If you choose not to participate, you will receive the usual care provided by your current health care provider at LHSC.

Version date: 15/April/13   Initials_____   1 of 2

www.manaraa.com

<u>Benefits:</u> There are no known benefits to you for participating in this study; however, participation may benefit society as the ability to offer appointments and surgery to patents in need of surgery in a timely manner can improve access to surgeries, like TKA and HTO that are in high demand.

<u>Confidentiality:</u>
All information collected will be kept in strict confidence. The company that takes care of the database is EmPower Health Research. Upon agreeing to participate in this study, you will be assigned a unique number by the database that will be linked to all of your information and data. Only your surgeon and his research staff will see your personal identifying information. Any other persons who are working with the data can only see your unique number and cannot see your personal identifying information.

Data that is collected will be username and password protected and stored on a server located in Montreal, Quebec. The company that houses the database for EmPower Health Research is a professional company with extremely high standards of physical and virtual security (Netelligent). It is important to understand that despite these protections, there continues to be the risk of unintentional release of information including your personal identifying 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. 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. Representatives of The University of Western Ontario Health Sciences Research Ethics Board may contact you or require access to your study-related records to monitor the conduct of the research.

If you have any questions about your surgery, please contact your orthopaedic surgeon. If you have any questions about this research, please contact the research assistant Laura Churchill ░░░░░░░░░░ or the principal investigator Dr. Steven MacDonald at ░░░░░░░░░░░░░░░░░░░░░░░░░░░░░░

If you have any questions about your rights as a study participant, please contact Dr. David Hill, Scientific Director, ░░░░░░░░░░░░░░░░░░░░

Completion of the questionnaire indicates your consent to participate.

☐ Yes I would like to participate and begin the survey.

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

Sincerely,

Dr. Steven MacDonald, MD, FRCSC
Dr. Robert Giffin, MD, FRCSC
Dr. Douglas Naudie, MD, FRCSC
Dr. James McAuley, MD, FRCSC
Dr. James Howard, MD, MSc, FRCSC
Dr. Richard McCalden, MD, FRCSC
Dr. Brent Lanting, MD, FRCSC
Dr. Edward Vasarhelyi, MD, FRCSC
Laura Churchill, MSc Candidate

Appendix C: Patient Questionnaire

Demographics

1. Date of birth:

Y Y Y Y   M M   D D

☐☐☐☐   ☐☐   ☐☐

2. **Do you have symptoms in both of your knees?** ○ Yes ○ No

3. **Gender:** ○ Male ○ Female

4. **Height:** ☐ feet ☐ inches

5. **Weight:** _____ ○ kgs ○ lbs

6. **Type of employment:**

○ Full-time   ○ Part-time   ○ Self-employed

○ Retired   ○ Student   ○ Stay-at-home caregiver

○ Unemployed/Social Assistance   ○ Volunteer

What is your occupation? (Enter your usual job title even if you are receiving compensation because of your knee problem) _____

Classify job demands:

○ Repetitive knee motion (i.e. squatting, kneeling, stairs, etc.)

○ No repetitive activity required

○ No knee activity required

○ Not applicable (Unemployed or retired)

7. Have you had to reduce your hours of work because of your knee problem?

○ Yes ○ No ○ N/A

8. Have you had to modify your duties at work because of your knee problem?

○ Yes ○ No ○ N/A

9. Please indicate your level of agreement with the following statement:

Returning to work and/or regaining function to perform all work-related duties is important to me

Strongly agree	*Agree*	*Neutral*	*Disagree*	*Strongly disagree*
○	○	○	○	○

Predictors of Surgical Consult for TKA

Willingness to undergo surgery:

Please indicate your willingness to undergo surgery if you were an appropriate candidate?

Definitely willing	*Probably willing*	*Unsure*	*Probably unwilling*	*Definitely unwilling*
○	○	○	○	○

If unsure, probably unwilling or definitely unwilling; do you think your willingness for surgery will change over the next 3 years?

○ Yes

○ No

○ Unsure

Please indicate why you are seeing the orthopaedic surgeon?

○ Knee osteoarthritis

○ New knee injury

○ Other: Please specify: _____

Please indicate your willingness to undergo a knee replacement if you were an appropriate candidate?

Definitely willing	*Probably willing*	*Unsure*	*Probably unwilling*	*Definitely unwilling*
○	○	○	○	○

☐ I do not believe that my knee problem requires a total knee replacement

Arthritis Health

1. Global rating of knee pain: considering all ways knee pain and arthritis affects you, how are you doing today

Very good ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Very poor
            0 1 2 3 4 5 6 7 8 9 10

2. Taking into account all the activities you have during your daily life, your level of pain, and also your functional impairment, do you consider that your current state is satisfactory? ○ Yes ○ No

3. Considering all the different ways in which your diseases affects you, if you were to remain in this state for the next few months, would you consider your current state to be satisfactory? ○ Yes ○ No

4. Previous treatment on knee: Have you tried any of the following treatments to relieve your knee pain (check all that apply):
☐ Pain Killers (e.g. regular or extra strength Tylenol)
☐ Narcotics (e.g. Tylenol #3, Percocet, etc)
☐ Anti-inflammatories (e.g. Advil, Naproxen, etc)
☐ Corticosteroid Injections
☐ Non-steroid Injections
☐ Physical Therapy
☐ Surgery
☐ Other (Please specify)

5. Please indicate the number of years you have been diagnosed with knee osteoarthritis: _____ **years**

6. Are you currently seeing a doctor for arthritis? ○ Yes ○ No

7. Do you currently use any walking aids to assist in ambulation? ○ Yes ○ No

8. Have you ever had surgery on your STUDY knee that was <u>not</u> a knee replacement?

(E.g. meniscal repair, HTO, knee scope, ACL reconstruction, etc.) ◯ Yes ◯ No

If yes please indicate which procedure:

☐ Meniscal repair
☐ Meniscal debridement (i.e. cutting or removing parts of the cartilage)
☐ HTO (i.e. high tibial osteotomy)
☐ ACL (anertior crucicate ligament) reconstruction
☐ Microfracturing (making holes) in the cartilage on the bones
☐ repair or implant to address a hole in the cartilage
☐ Other- please describe: _____

Please indicate which tests you have already undergone on your knee:

☐ CT   ☐ X-ray
☐ MRI   ☐ Other_____
☐ MRI (arthrogram) ☐ Ultrasound

Predictors of Surgical Consult for TKA

Lifestyle

1. Do you participate in sport on a weekly basis? ○ Yes ○ No

   If yes, what level of sport do you participate in?
   ○ Elite
   ○ Varsity
   ○ Competitive
   ○ Recreational
   ○ None

   If no, does your knee impair you from your desired level of sport participation?   ○ Yes ○ No

   If yes, how important to you is returning to sport after surgery and rehabilitation?

Very important	Somewhat important	Neutral	Not very important	Not at all important
○	○	○	○	○

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Predictors of Surgical Consult for TKA

Medication Form

Are you taking any medications *related to your knee pain?* For each medication listed below, if you are taking the medication then please indicate this by clicking on the box beside the medication. For each medication that you indicate that you are taking, please indicate how often you are taking that medication (daily, weekly, occasionally).

Yes No
○ ○ Non Steroidal Anti-Inflammatory Drugs (NSAIDS)

Medication			
☐ Aspirin	○ Daily	○ Weekly	○ Occasionally
☐ Celebrex	○ Daily	○ Weekly	○ Occasionally
☐ Indomethacin (Indocid)	○ Daily	○ Weekly	○ Occasionally
☐ Ibuprofen (Advil)	○ Daily	○ Weekly	○ Occasionally
☐ Diclofenac (Voltarin, Arthrotec)	○ Daily	○ Weekly	○ Occasionally
☐ Mobicox (Meloxicam)	○ Daily	○ Weekly	○ Occasionally
☐ Naproxen (Naprosyn)	○ Daily	○ Weekly	○ Occasionally
☐ Other (please list): _____	○ Daily	○ Weekly	○ Occasionally
☐ Other (please list): _____	○ Daily	○ Weekly	○ Occasionally

Are you taking this/these medications because of your knee problem? ○ Yes ○ No

2013/04/22 10:19 AM

Yes No

◯ ◯ **Pain Killers**

☐ Tylenol Regular Strength   ◯ Daily ◯ Weekly ◯ Occasionally

☐ Tylenol Extra Strength   ◯ Daily ◯ Weekly ◯ Occasionally

☐ Other (please list): _____ ◯ Daily ◯ Weekly ◯ Occasionally

☐ Other (please list): _____ ◯ Daily ◯ Weekly ◯ Occasionally

Are you taking this/these medications because of your knee problem? ◯ Yes ◯ No

Yes No

◯ ◯ **Narcotics**

☐ Morphine   ◯ Daily ◯ Weekly ◯ Occasionally

☐ Oxycodone (Percocet, Oxycocet, Endocet) ◯ Daily ◯ Weekly ◯ Occasionally

☐ Demerol   ◯ Daily ◯ Weekly ◯ Occasionally

☐ Codeine   ◯ Daily ◯ Weekly ◯ Occasionally

☐ Talwin   ◯ Daily ◯ Weekly ◯ Occasionally

☐ Methadone   ◯ Daily ◯ Weekly ◯ Occasionally

☐ Tylenol #2, Tylenol #3 ◯ Daily ◯ Weekly ◯ Occasionally

☐ Other (please list): _____ ◯ Daily ◯ Weekly ◯ Occasionally

☐ Other (please list): _____ ◯ Daily ◯ Weekly ◯ Occasionally

Are you taking this/these medications because of your knee problem? ◯ Yes ◯ No

Appendix D: Original Surgical Consultation Form

Predictors of Surgical Consult for TKA

Surgical Consultation Form

PID _____

Name of referring clinician: _____ Please specify:

_____

Name of completing surgeon: _____

Did this patient have x-rays done that were ordered by the referring physician? ◯
Yes ◯ No

If yes, did the series of x-rays include the preferred views (i.e. appropriate weight-bearing films)? ◯ Yes ◯ No

Outcome of consultation:

1. Based on looking at the patient's radiograph is this patient is appropriate for: TKA?

A) ◯ Yes, this patient is appropriate, I would triage them in the following way:

◯ Priority-rating 1: The surgical consult for this patient should have occurred **sooner**

◯ Priority-rating 2: The surgical consult for this patient was at the **appropriate** time

◯ Priority-rating 3: The surgical consult for this patient could have **waited**

◯ Priority-rating 4: The surgical consult for this patient was **unnecessary** at this time

B) ◯ No, this patient should **never have been referred for arthroplasty**, but is appropriate for **HTO**.

Why?
◯ Lack of advanced arthritis
◯ Patient age
◯ Patient occupation
◯ Patient expectations

○ Other: (explain)

_____

C) ○ No, this patient is **not a surgical candidate**

   ○ Insufficient symptoms

   ○ Patient not desiring of surgical intervention

   ○ Too many Comorbidities

   ○ Misdiagnosis (alternative cause for patient's symptoms i.e. back pain)

   ○ Other: (explain)

_____

Appendix E: Pre-Screened Patients Form

Predictors of Surgical Consult for TKA

Pre-Screened Out

Date: ☐☐☐☐-☐☐-☐☐
    Y Y Y Y   M M   D D

Gender: ◯ Female ◯ Male

Age: ☐☐☐

Name of referring clinician: _____

Reason patient not booked for consult:

☐ Lack of advanced Arthritis

☐ Insufficient Symptoms

☐ Not OA

☐ Acute Injury

☐ Meniscal Repair

☐ Other _____

Are you referring this patient to sports? ☐ Yes ☐ No

Appendix F: New Surgical Consultation Form

Predictors of Surgical Consult for TKA

Surgical Consultation Form

PID _____

Name of referring clinician: _____   Please specify: _____

Name of completing surgeon: _____

1. Did this patient have x-rays done that were ordered by the referring physician?
   ○ Yes   ○ No   ○ Unknown

   If yes, did the series of x-rays include the preferred views (i.e. appropriate weight-bearing films)?   ○ Yes   ○ No   ○ Unknown

Outcome of consultation:

2. Based on looking at the patients radiograph is this patient appropriate for TKA?

A) ○ Yes, this patient is **appropriate**, I would triage them in the following way:

   ○ Priority-rating 1: The surgical consult for this patient should have occurred **sooner**

      Please provide reasons:
      ☐ Patient's arthritis has been advanced for a long time with symptoms
      ☐ Other: _____

   ○ Priority-rating 2: The surgical consult for this patient was at the **appropriate** time

      Is this patient being booked for surgery?
         ○ Yes
         ○ No   Please explain
            ☐ Patient not desiring of surgical intervention
            ☐ Too many Comorbidities
            ☐ Other: (explain) _____

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○ Priority-rating 3: The surgical consult for this patient could have **waited**

☐ Lack of advanced arthritis

☐ Patient age

☐ Patient occupation

☐ Patient expectations

☐ Insufficient symptoms

☐ Patient has not had sufficient conservative management (e.g. PT, injection, etc)

☐ Patient is perhaps more appropriate for sports

　　○ Yes ○ No Are you referring this patient to sports (e.g. for an HTO or scope)?

☐ Other: (explain) _____

B) ○ No, this patient should **not have been referred for arthroplasty at this time**

Why?

☐ Lack of advanced arthritis

☐ Patient age

☐ Patient occupation

☐ Patient expectations

☐ Misdiagnosis (alternative cause for patient's symptoms i.e. back pain)

☐ Insufficient symptoms

☐ Patient has not had sufficient conservative management (e.g. PT, injection, etc)

☐ Patient is perhaps more appropriate for sports

　　○ Yes ○ No Are you referring this patient to sports (e.g. for an HTO or scope)?

☐ Other: (explain) _____

Appendix G: List Of Predictors

1.Age, 2.BMI, 3.Employment status, 4.Occupation requiring knee activity, 5.Reduce hours/modify work duties because of knee problem, 6.Willingness to undergo surgery 7.Willingness to undergo surgery in 3 years, 8.HADS anxiety score, 9.HADS depression score, 10.KOOS pain score, 11.KOOS symptoms score, 12.KOOS ADL score, 13.KOOS sport/recreation score, 14.KOOS ADL score 15.KOOS sport/recreation score, 16.WOMAC pain score, 17.WOMAC stiffness score, 18.WOMAC pain score, 19.WOMAC function score, 20.KSS overall score, 21.UCLA activity rating scale, 22.ICOAP constant pain score, 23.ICOAP intermittent score, 24.Oxford knee score, 25.WCWL-HKPT score, 26.Sport participation, 27.SF-12 Mental component score, 28.Medication use, 29.Charlson comorbidity score, 30.Global rating of knee pain, 31.PASS, 32.Number of previous conservative treatments on knee, 33.Number of years diagnosed with OA, 34.Past non-arthroplasty knee surgery, 35. Currently seeing a physician for Osteoarthritis

Curriculum Vitae

Laura Churchill

EDUCATION

Master of Science	Health and Rehabilitation Sciences (Physical therapy field) *University of Western Ontario, London ON* *Sept 2012-Present*
Honours Bachelor of Arts Kinesiology *Dean's Honour Roll*	Honours BA Kinesiology and Physical Education *Wilfrid Laurier University, Waterloo ON* *Class of 2012*

RESEARCH EXPERIENCE

University of Western Ontario London, On 2012-Present	A Model To Reduce The Proportion Of Inappropriate referrals to surgery for patients with OA: A Pilot Study Role: Co-investigator: patient recruitment/data collection/analysis
Wilfrid Laurier University Waterloo, On Undergraduate Thesis 2011-2012	Assessing Ontario elementary pre service teacher's level of preparedness to implement DPA & PE: A qualitative study Role: Co-investigator; conducted semi-structured interviews, transcribed and extracted relevant themes
Research Assistant	Beneficial effects for older adults participating in a balance/strength training exercise program aimed at reducing falls Role: Research Assistant; assisted in COP/COM force plate measurements and administering patient questionnaires

PUBLICATIONS, PAPERS AND PRESENTATIONS

University of Western Ontario

Presentations:

- **Fowler-Kennedy Sports Medicine Clinic- Research Rounds**
- **University Hospital- Orthopaedic Research Rounds**
- **Western Research Forum 2013**
- **Three Minute Thesis Competition- 3MT 2013**

HONOURS & AWARDS

2010-2011, 2011-2012   WLU Dean's Honour Roll: Faculty of Science

2012-2013   University of Western Ontario Graduate Research Scholarship

TEACHING EXPERIENCE

University of Western Ontario
London, ON
Spring 2013

Teaching Assistant- School of Physical Therapy
PT 9524